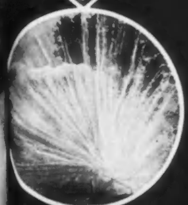
CHEMISTRY



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Near Absolute Zero

➤ BECAUSE a gas a long way above the temperature at which it liquifies will expand or contract by $\frac{1}{273}$ of its volume for each degree of change on the Centigrade thermometer scale, physicists of the 19th century postulated the temperature of absolute zero (0° Kelvin) at —273° C. (—459° F.). They set out to reach as low a temperature as they could. They achieved liquid air. They discovered the inert gases which make up a small fraction of the atmosphere.

Some few gases still resisted freezing, and new principles were applied to the problem of making the remaining liquid cool itself a little further. After expansion and contraction, as in the heat-pump cycle of present day refrigeration machines, had been made to give up as much heat as is practical, the energy of magnetization and demagnetization has now been harnessed for still further reduction of temperatures already very low.

Meantime the idea of absolute zero has changed greatly. No longer is it imagined as the temperature at which all molecular motion stops. The quantum theory has put a different interpretation on the conditions of molecular motion. Instead of proceeding quietly to extinction, a gas is now visualized as having a chance to contain livelier molecules at even lower temperatures than was once thought possible.

But more interesting than any theorizing about how the molecules may behave is the world of unexpected phenomena which has been discovered as one substance after another has been subjected to lower and lower temperatures producd by the new cooling devices. Helium has been found to change to a fourth state of matter. Metals show electrical properties that formerly would not have been dreamed of.

Now engineers want to wall off tiny insulated spaces where small-scale devices can be operated under these fantastically cold conditions, in order to put the newly discovered laws of nature to work.

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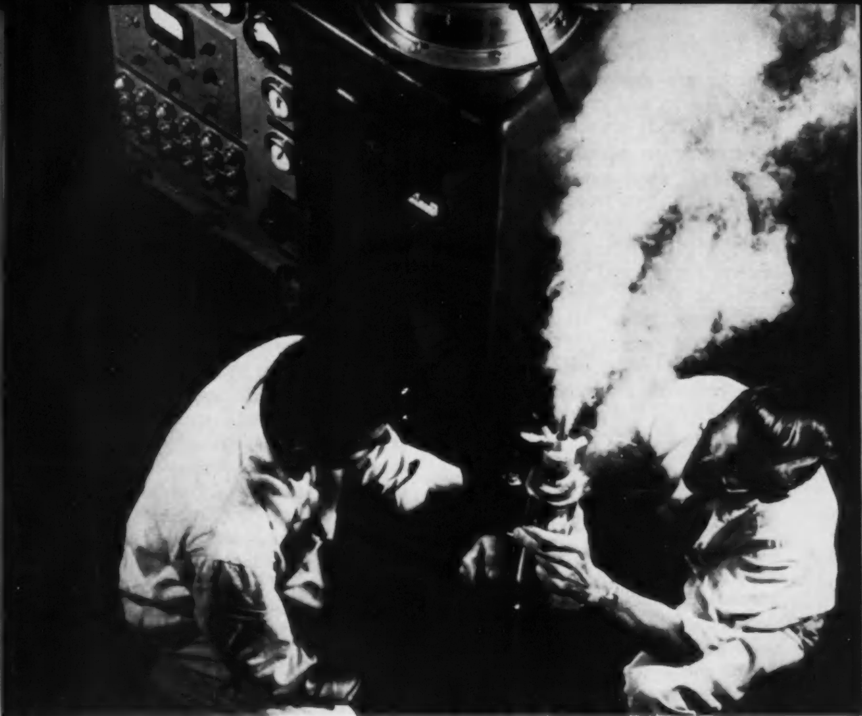


➤ Liquid *helium at a temperature of minus 452 degrees Fahrenheit is being transferred from a Cryostat to an experimental container by scientists at the Arthur D. Little, Inc., research laboratory. Helium at this temperature boils and froths like boiling water.*

Far Below Zero

by D. H. Radler

➤ How cold is cold?

To most of us, it is pretty chilly when the thermometer drops to freezing, 32 degrees Fahrenheit. But even if you were in the coldest spot in the world, near the Siberian villages of Oimekon and Verkhoyansk, where a record 90 degrees below zero has been recorded, you have not come near what the physicist calls cold.

To him it is not cold until temperatures plunge to 459 degrees below zero Fahrenheit, just above "absolute zero," the unattainable state of complete absence of heat. The physicist measures these temperatures in "degrees Kelvin:" the Fahrenheit figures of minus 452 degrees and minus 458

degrees are approximately four degrees Kelvin and one degree Kelvin on the absolute scale.

At these temperatures, every element and every compound in the world is a hard-frozen solid, with the single exception of helium. Normally a gas, helium liquefies at 4.2 degrees Kelvin, and stays liquid clear down as close to absolute zero as science can come. Because of this unique and convenient property, scientists use liquid helium to chill other materials to temperatures within a degree of absolute zero.

Why are they so interested in lower-limit temperatures?

Heat Motion Slows Down

Because the laws of nature stand out starkly when the temperature is really low. Normally, atoms and molecules dance crazily about in a "heat motion jig" that makes the intimate study of matter difficult. But at extremely low temperatures, the jig slows down and becomes a stately minuet. Aided by this comparative stillness, physicists can probe the fundamental behavior of atoms and molecules, adding to the known laws of nature which they codify in the complex mathematical jargon known as "quantum mechanics."

What makes a solid solid? What are the forces that hold atoms together? These are two of the basic questions which science tries to answer through low temperature research.

Practical applications flow forth from low temperature labs, too. The super-strong steels used when terrific stresses demand incredible strength are products of low temperature studies in which it was learned that controlling the amount of nitrogen in steel affects its strength. Steelmen have also been able to make an extremely hard stainless steel simply by quenching the molten metal in liquid nitrogen at minus 320 degrees Fahrenheit before rolling or forging it. Such muscular metals, engineered for resistance to temperature extremes, should be useful when we take a crack at the space barrier. In the vast vacuum outside the blanket of our atmosphere, it is plenty cold!

Even with such practical triumphs to its credit, low temperature research is about as "pure" as pure science can get. For every experiment that leads to some new product or process, thousands of others yield information of only theoretical interest. But every little insight into the laws of nature, however impractical it may seem, ultimately means better living for all of us. Hard-headed businessmen recognize this full well. Such companies as General Electric and Westinghouse, for example, maintain some of the world's best low temperature research laboratories.

Surprises at Near Zero

Exciting surprises that turn up near absolute zero make this work fascinating to the scientist and intriguing to the layman. Take the behavior of helium itself.

At 4.2 degrees Kelvin, where it liquifies, helium bubbles and froths just like boiling water. Well it might, for this frigid temperature, minus 452 degrees Fahrenheit, is actually its boiling point. A few notches lower on the temperature scale, helium calms down and behaves like a normal liquid. But at 2.2 degrees Kelvin, helium turns into what scientists call

a "superfluid," and its behavior is strange indeed. Dip a cupful from a pool of liquid helium and here's what happens:

Seemingly defying gravity, it flows up the walls of the cup and down the outside, forming drops on the bottom that plop back into the pool, acting for all the world like a mass of tiny mites trying to get back home! This is because superfluid helium (technically called helium II) has virtually no viscosity, or "stickiness": its atoms slip past one another with extreme ease, flowing in all directions, even against gravity. This means that anything you keep the stuff in can not have even the tinest of holes, or the liquid helium will sneak out.

Helium Fountain

Now take a tube filled with emery powder and suspend it in a liquid helium bath, letting the thin neck of the tube stick out above the surface. Shine a 150-watt lamp on the tube, and here comes the liquid helium, spurting up in a foot-high fountain! Physicists are still looking for a complete explanation of this one.

Another fascinating effect of low temperatures is the way electricity will flow around a ring without any visible source of current. Normally, current will flow as long as it is supplied by a battery or some other source. But at low temperatures, a ring of metal, once a current is started in it, will carry the current 'round and 'round indefinitely after the battery is turned off! "Superconductivity," as this is called, occurs at low temperatures in a score of metals and many metallic compounds, but only in those materials which are poor conductors at room temperature, such as lead. From the complex explanation of this seeming contradiction, scientists learned a great deal about the subtle differences between good and poor electrical conductors.

Electricity is carried by electrons, the tiny particles that whirl around atomic nuclei and give various elements their characteristic chemical properties. In most metals, the atoms are unable to control all their electrons, leaving some free to flow when a current is supplied. At room temperature, that old heat motion dance causes collisions which rob these "free electrons" of their energy. But near absolute zero, there is virtually no agitation and the only resistance to the flow of current comes from impurities in the metal or from defects in the crystal structure of the regularly-arranged atoms. Electron motion around atomic nuclei is truly "perpetual motion." Scientists believe that they are duplicating this every time they cool a metal and turn it into a superconductor. Nevertheless, superconductivity is far from fully understood, and one of the goals of current low temperature research is to explain it.

Elaborate Cooling Devices

Superconductors might have wide practical applications, but they will not work unless they are kept at or near liquid helium temperatures. This calls for elaborate cooling devices, making machinery employing superconductors cumbersome and expensive. One application which the Army actually tried during World War II was in a gadget that detects radiant enegy of all kinds, called a "bolometer." Because superconductors are stupendously sensitive to energy

changes, low temperature bolometers can spot radiation hundreds of times faster than ordinary bolometers, reacting to differences as slight as a ten-millionth of a degree! Superconductors also have promise as shields to keep atmospheric magnetic effects out of any area where these ever-present disturbances might be harmful, such as a laboratory doing sensitive radio, TV or radar research. Superconductors can perform this feat of seeming magic because they repel any magnetic field. If this sounds something like anti-gravity to you, you are absolutely right: a small permanent magnet literally floats in the air over an active superconductor!

Not many years ago, liquefying helium was such an expensive and difficult process that only the wealthiest laboratories could afford to dabble in low temperature work. But today, thanks to the ingenuity of Dr. Samuel Collins of Massachusetts Institute of Technology, nearly 100 laboratories are probing the secrets of matter at liquid helium temperatures. Working in cooperation with Dr. Collins, Arthur D. Little, Inc., of Cambridge, Mass., developed a fairly simple small, and relatively inexpensive (about $25,000 to $30,000) machine known as the ADL Collins Helium Cryostat, which reduces the temperature of helium by making it do work; the compressed gas pushes against a piston, losing heat as it loses energy. (You can observe this principle for yourself by rapidly pulling out the piston of a bicycle pump, causing the air inside to cool.)

One of the first universities to leap into low temperature research when this machine went on the market was Purdue, where solid state studies had already led to the development of the fabulous little transistor which has revolutionized the electronics industry.

Purdue's solid state physicists are now pioneering in another scientific area. Under the direction of Dr. Karl Lark-Horovitz, they are bombarding solids with high-energy particles from nuclear accelerators and atomic piles, and then studying at low temperatures the changes caused by the atomic barrage. One thing they have learned: damaged solids sometimes "heal" of their own accord, and can be helped by heating. This could be enormously important in nuclear engines such as those used in the submarines Nautilus and Sea Wolf, where constant atomic bombardment may change the properties of structural materials radically unless sufficient healing takes place.

Magnetic Cooling

With liquid helium, scientists can reach temperatures within one degree of absolute zero, but they would like to get even closer than that to the unattainable state of complete absence of heat. Prof. J. G. Daunt of Ohio State University has worked out a method to do this, and Arthur D. Little, Inc., has made a "magnetic refrigerator," based on Dr. Daunt's design, commercially available. With this machine, they guarantee temperatures as low as 0.25 degrees Kelvin, which can be sustained for long periods of time. This super-cooler is based on the reaction of the electrons in certain metal salts to a changing magnetic field. Because the actual cooling step is taken when the magnet is turned off, the process is known

as "electron demagnetization." With this method, temperatures as low as one-and-a-half thousandths of a degree have been reached.

It is at least theoretically possible to reach temperatures much lower than this, perhaps a mere hundred-thousandth of a degree above absolute zero, if the demagnetization technique can be worked on atomic nuclei as well as on electrons. But although many laboratories hope to make this scientific dream come true, none has so far succeeded.

But even though it is impossible to reach absolute zero, scientists try to get as close to frigid perfection as they can. It is just such striving, the laboratory equivalent of trying to scale Mt. Everest, that leads to progress in science.

On the Back Cover

➤ DR. IVAN SIMON, *research physicist at Arthur D. Little, Inc. prepares to operate a new-type refrigerator which will maintain lower temperatures than any previous apparatus. The temperature of the refrigerated space — the slender tube at the lower left — comes within a few tenths of a degree of Absolute Zero (—459.6°F). Working at these extreme low temperatures, scientists hope to gain a better understanding of the basic properties of matter. A major departure from ordinary refrigerating systems, this machine has no moving parts or flowing fluids in the refrigeration section. It uses a special salt in a 3-inch long plastic capsule as the refrigerant.*

Chemicals Less Random as Evolution Progresses

➤ A CHEMICAL tie with evolution was reported by Drs. K. Laki and D. R. Kominz of the National Institutes of Health at a symposium on research methods and instrumentation held recently.

The tie relates to the distribution of protein-building amino acids in a special muscle protein, tropomyosin. The uneven distribution of the amino acids in the protein gets less random the higher in the evolutionary scale the animal is.

The scientists examined amino acid distribution in tropomyosins from human uterus, calf heart, rabbit skeletal muscle and uterus muscles, carp muscle, lobster and earthworm and flatworm.

Device in Liquid Helium
Is Electronic Switch

Cold Logic

From The Industrial Bulletin of Arthur D. Little, Inc.

➤ Low TEMPERATURE research has led to the development of the cryotron, which can serve as a nearly perfect electronic switch. In its simplest form, the cryotron consists of a straight piece of wire approximately $\frac{1}{10}$ of an inch long, wound with a single layer of control wire about the size of a human hair. This very small device may have far-reaching influence on the future development of electronic computing machines.

The cryotron operates in a bath of liquid helium, only a few degrees above absolute zero; at such extreme low temperatures, many metals are said to be superconductive, i.e., they offer no resistance to the passage of electrical current. A metal that has been cooled to the superconducting state regains its normal resistance in the presence of a sufficient magnetic field. When the cryotron is cooled by liquid helium, the central wire can be made superconductive or resistive at will by raising or lowering the magnetic field created by the control current flowing in the surrounding coil. Thus the cryotron performs the same functions as an electronic switch —it makes, breaks, or changes connections in an electrical circuit.

As a passive switch, one that simply turns electrical current on or off, cryotrons can compete favorably with transistors and diodes, whose resistance when "open" can be as high as 100,000 times higher than when "closed." The cryotron offers the possibility of an entirely new concept of switching circuits; its ratio of open to closed resistance is theoretically infinite.

The cryotron can also function as an active switch or current amplifier, in that it can control a larger current than is required for its own actuation. Thus, great numbers of cryotrons can be interconnected to form the logical network of an electronic computer, as can vacuum tubes and transistors. So far, cryotrons have been unable to match either of these devices in switching speed, although their unusually small size, exceptionally low cost, and high reliability make them more attractive than transistors and vacuum tubes for many applications. It may one day be possible to build a large-scale digital computer that will occupy only one cubic foot, exclusive of refrigeration and terminal equipment. This represents a space saving of approximately 20 to 1 compared to transistor computers, and perhaps 300 to 1 compared to vacuum tube computers.

Getting rid of unwanted heat is an important consideration in electronic computer design. It takes an average of two watts of otherwise "useless" power to heat up the filament of a vacuum tube so that it will operate; this poses a severe problem

of heat dissipation in a multi-tube computer. By contrast, the heating requirement is only a few thousandths of a watt for transistors and only one-hundredth of that for cryotrons. A large scale digital cryotron computer may give off as little as ½ watt of heat totally, again excluding terminal equipment and refrigeration. The power expenditure in a cryotron computer is almost zero, moreover, since currents flow only in superconducting paths where the electrical resistance and power wastage is vanishingly small.

Because the cooling requirements for the cryotron are so small, it appears that liquid-helium refrigerated computers may be commercially feasible. An adequate supply of liquid helium can be stored easily, compactly, and safely; with suitable refrigeration equipment, the helium would not have to be replenished frequently.

One of the first applications of the cryotron will be in an electronic catalogue or memory that will store about two thousand "words" of information in appropriate categories. (One "word" consists of a number of letters or characters, each in the form of a binary code, which is the universal "language" of electronic computers.) When questioned, the machine will tell whether a particular word is contained in its memory, and, if so, in which category. A later modification of this machine might be a mail order catalogue that would "remember" the stock number of many items and keep an account of the quantity on hand. Another early application will probably be an automatic dictionary for literal translation of foreign words and phrases.

Although cryotrons show considerable promise for electronic computation, it is too early to estimate the extent of their commercial practicability. For some uses, their operating speed is now too slow; conceivably, it can be increased at least a hundredfold by further research and development.

Particles Called Self-Maintained Excitations

➤ A NEW LOOK at the elementary particles deep within the atoms and in innermost space has caused Dr. F. A. Kaempffer of the University of British Columbia's department of physics to suggest that a particle is a self-maintained exitation of the medium in which it exists.

He illustrates the situation by explaining that in a primitive model, described by equations, photons (gobs of light radiation) and neutrinos (a massless entity) are considered as basic building stones, each acting as the glue that holds the other together.

Present theories of elementary particles do not allow an understanding of the coupling of the particles with the electro-magnetic field and with each other or the origin of their masses.

Dr. Kaempffer hopes that his theory will ultimately give understanding of all particles, from the electron up to the unstable nuclei of the heaviest elements.

Blame Chemical Advances
For Poisoning Increases

Poisons Told by Odor, Shape

➤ ADVANCES in chemical technology are held responsible in part for the increasing death rate from accidental poisoning of children, in a report by Sidney Nobel of the newly established poison control center of Monmouth Memorial Hospital, Long Branch, N. J.

The increasing number and variety of poisoning problems confronting the hospital laboratory may be due in some degree to the advances in chemical technology which have introduced a wide range of noxious chemicals into the home area. There has been a rapid development of new compounds which sometimes result in exposing workers to industrial toxic hazards despite precautions taken in the industrial plants.

In an exhibit for the First International Congress of Clinical Chemistry Mr. Nobel showed an integrated preventive program which includes public education and close liaison between the hospital emergency room and a well equipped and competently staffed hospital laboratory.

Included is an odor reference shelf to aid in rapid identification of those poisons which possess characteristic odors, and a master chart indicating the wide variety of colors, color combinations, shapes, and sizes of proprietary and ethical pills and capsules.

Extreme caution is urged in dealing with unknown compounds. For example, an unmarked paper bag filled with grayish granules was found near a corpse. At the Monmouth Memorial Hospital Poison Control Center, the granules were later identified as calcium cyanide.

Poisonous substances are found in such common household products as throat lozenges, shoe polish, bleach, detergents, depilatories, furniture polish, suntan lotion, and the fluid found in Christmas tree lights. All of these have been involved in cases where children have been treated for poisoning at Monmouth Memorial Hospital.

The Poison Control Center of Monmouth Memorial Hospital under the direction of Martin L. Rush, director of laboratories, is the only such Center in any private hospital in New Jersey. Working in cooperation with the United States Public Health Service, the New Jersey Department of Health, Rutgers University, and several private foundations and firms, the Center provides analyses of poisons and treatment of poison victims throughout Monmouth County and information to physicians and others in the area.

The first warehousing of titanium metal has been initiated in Los Angeles.

Of a sample of 211 prospective elementary school teachers, 150 had a long-standing hatred of mathematics.

Fleas, Silo Gas and Liver Diagnosis Reported

Radioactive Tracer Research

➤ Deadly silo gas which has been killing farmers over the years has had its origin detected by use of radioactive nitrogen.

The gas is nitrogen dioxide. Adding radioactive nitrates and amino acids to forage before starting silage-making showed University of Wisconsin's emeritus professor William H. Peterson that the dangerous gas is formed from nitrates by the action of bacteria.

These bacteria change the nitrates to nitrites, which are converted to nitrous acid and then to nitric oxide gas, particularly in the presence of carbon dioxide evolved at the beginning of silage fermentation. In contact with the air, the nitric oxide becomes nitrogen dioxide. The heavy gas accumulates in pockets at the bottom of the silo and seeps into the small room between silo and barn.

Farmers entering the silo may breathe in deadly quantities of the gas. Although in large quantities the gas may be seen as a yellow or brown fog, smaller but still toxic quantities may be invisible. They can be detected by the bleach-like odor.

The gas is formed during the first few days of silage-making. Farmers are warned against entering unventilated silos for five to 10 days after filling.

Fleas Tagged Atomically

➤ Science can now zero in on the intimate life and habits of the flea by means of radioactivity.

The purpose is to uncover new facts about fleas that will provide more insight into how the insects spread plague among wild animals and to man.

Success in getting a radioactive "handle" on fleas, apparently for the first time, has been reported by a team of scientists working for the University of California School of Medicine and the U.S. Public Health Service. The scientists are Drs. S. F. Quan, W. V. Hartwell and Kenneth G. Scott.

Fleas have been considered uncommonly difficult to tag with radioactivity because no way could be found to get the radioactivity into the insect's system. But these scientists noted that cerium 144 is very sticky, and adheres tenaciously to living things. So they put fleas on water containing a suspension of cerium 144, and the isotope stuck to the insects' horny coating.

Now the scientists can begin field studies: Tagging fleas, turning them loose on wild rodents, and tracing them with counters as the insects hop from rodent to rodent and to other animals and man. The radioactivity of cerium 144 lasts for a considerable time, and the quantity needed is so minute as to be entirely safe for the host animal, scientific workers and any possible casual human contacts.

The radioactive fleas will not, of course, be infected with plague. The scientists are just interested in the

living habits of the flea. They want to know how readily the flea migrates from one animal residence to another, from wild to domestic rodents, and then on to man. They also expect to learn how long fleas live in their natural environment—an unanswered question.

The radioactivity tagging method may also be useful in similar studies of ticks, lice and other insects whose habits have been difficult to trace.

Plague, the ancient "Black Death," is a rare affliction in the United States, although deaths from it occasionally occur. There are permanent reservoirs of the infection in wild rodent populations, however.

Liver Diagnosis Aid

➤ A RADIOACTIVE form of the dye, rose bengal, is helping diagnose liver disease, Dr. H. L. Friedell of Cleveland has reported to the American Roentgen Ray Society.

Efforts during the past 40 years to see the liver by X-rays have not been successful.

With the new radioactive dye and a scanner similar to a Geiger counter, a series of dots and dashes, called hepatoscans, are giving doctors a chance to detect liver enlargement, displacement, pressure on the liver by a mass outside and conditions such as tumors that take up space inside the liver.

Important to the new technique is a "cut-off" circuit. This allows recording of only a certain level of uptake by the liver. The information actually recorded then gives the physician conducting the examination somewhat more well defined diagnostic clues.

In general, with the cut-off technique, it is somewhat easier to delineate defects by the absence of radioactivity rather than by observing areas of increased activity.

These techniques have been extended to problems of delineating other organs and some progress has already been made along these lines.

Beer Making By-Product May Have Atomic Use

➤ A BY-PRODUCT of Swedish beer-making may prove valuable to atomic energy makers.

Percolation through barley as a new method for separating heavy water from the ordinary kind is reported by three Swedish scientists in an article published in the scientific journal, *Nature*.

In malting barley for Swedish beer, large amounts of water are taken up by the grain. The scientists, L. Carlbom, R. Skjoldebrand and N. Neilsen of Stockholm reported that after testing the water which had been percolated through the barley they found it richer in heavy water than the Stockholm tap water.

Whether barley takes up light water by preference or exchanges for light water some heavy water in its tissues during the percolation process, the Swedish physicists point out that enrichment of heavy water is expensive. A biological method of producing heavy water as a by-product of malting barley seems promising to the Swedish scientists.

Chemistry In Medicine

➤ ION EXCHANGE resins can be incorporated into bandages and ointments to act as "time bombs" against disease, Dr. Glen J. Sperandio, Purdue University associate professor of pharmacy, announces.

With Drs. Wilson Nashed and William Fiedler, he has devised a plastic bandage and an ointment which contain ion exchange resins—hard, bead-like synthetics which are insoluble and non-toxic. Loosely adsorbed on the surfaces of the resinous beads are charged particles of medicine—streptomycin and Neomycin in the two cases tried so far. Coming in contact with the skin, the resins exchange their positively-charged medicinal ions for free hydrogen ions from the blood serum.

This ion exchange takes place gradually, maintaining a constant level of antibacterial or antibiotic action for two weeks or more. The plastic bandage is designed for use on extensive burns, where it promises to eliminate frequent and painful changes of dressings. The ointment might be used for superficial cuts and for skin infections such as poison ivy, where it would provide a full course of treatment in one application.

Pure Skin Color Hormone

➤ INTERMEDIN, the pigmentation hormone which gives color to the skin, has been isolated in pure form and its chemical structure determined by University of California scientists.

The research on what has appeared a minor hormone has broad implications for progress in treatment of metabolic diseases. The work marks the first time a specific biological function apparently can be pinned down to a specific structural segment of a large complex pituitary hormone.

It shows hormones like ACTH are probably several hormones rolled into one. Possibly purification or synthesis of the fragments may bring better, more specific treatment.

The scientists, after purifying intermedin (MSH or melanocyte-stimulating hormone), showed it is composed of 18 amino acids in a simple peptide chain. The striking thing is that a segment of seven of these amino acids are arranged in the same sequence as a similar segment of ACTH. The sequence is methionine, glutamic acid, histidine, phenylalanine, arginine, tryptophane, glycine.

ACTH has been known to contain MSH activity for many years and until recently was believed its only source. But recently extracts of MSH were obtained and this secretion was identified as a separate hormone produced by the intermediate lobe of the pituitary.

This separate hormone could darken the skin of frogs, fish and other animals just as ACTH could. The University of California scientists say a segment of seven amino acids in both hormones is undoubtedly re-

sponsible for pigmentation. In ACTH this sequence acquires adrenal stimulating activity because of the different order of amino acids on each side.

The scientists believe the wide variety of biological effects of the large pituitary hormone molecules eventually will be pinned down to structural segments of the molecules. For example, ACTH causes fatty liver and an increase of red blood cells in addition to stimulating the adrenals and causing pigmentation. Small segments may be responsible not only for pigmentation but for other activities as well.

The researchers are Drs. Irving I. Geschwind, C. H. Li and Livio Barnafi, all of the Hormone Research Laboratory at Berkeley. Dr. Li and other colleagues previously have isolated five pituitary hormones, including ACTH, growth, lactogenic, interstitial-cell-stimulating and follicle stimulating.

Vitamin B-12 In Milk

➤ Bossy the cow gives anti-anemia vitamin B-12 in her milk, regardless of what she herself eats, so long as she gets enough cobalt in her feed. Nor does her breed make any difference. Holsteins and Jerseys give practically the same amount of the vitamin in their milk.

The reason is that the bacteria in the cow's rumen synthesize the vitamin, U.S. Department of Agriculture scientists report.

Pasteurization does not destroy the vitamin. Neither does storage in a household refrigerator for three days.

Cheese, which is made from milk of course, also contains the vitamin. Natural Swiss cheese has the highest count for this vitamin among cheeses tested. Next comes natural Cheddar, either mild or sharp. Then come processed Swiss cheese, processed Cheddar and cottage cheese.

The great vitamin B-12 content of Swiss cheese is believed due to synthesis of the vitamin by propionic acid bacteria involved in the manufacture of this cheese.

M. S. Clue In Lactic Bacteria

➤ The lactic acid bacteria that turn milk sour are giving clues to the human body's faulty chemistry that leads to multiple sclerosis.

The studies are being carried out by Dr. Merrill N. Camien in the laboratory of Dr. Max S. Dunn at the University of California at Los Angeles, with the support of the National Multiple Sclerosis Society.

During radiation experiments with lactic acid bacteria, a mutant strain was produced which had different nutritional requirements than normal strains. Without specialized fat substances, known as alpha-hydroxy fatty acids, the mutant bacteria would not grow.

Alpha-hydroxy fatty acids, as well as other complex types of fatty acids, occur conspicuously in fats of nervous tissue, including myelin, the fatty substance that comprises the sheath around nerves. In multiple sclerosis this sheath undergoes rapid degeneration as a result of derangement of biochemical processes involved in its normal maintenance.

Through a study of these mutant bacteria which require alpha-hydroxy fatty acids, the UCLA scientists hope to learn more about the complex processes by which relatively simple

forms of these fatty acids are converted to the more complex forms found in nervous tissue. Thus a clue may be obtained to where body chemistry goes awry, leading to degeneration of fatty myelin tissue.

Alcoholism "Cure" In Chemical?

➤ BECAUSE printers working on color presses developed a violent reaction after drinking as little as six ounces of beer, medical science may have "a new cure for alcoholism."

The new "cure" would be like the famous Antabuse cure and would work in the same way and for the same reason.

The chemical that would be used instead of Antabuse would be N-butyraldoxime. Persons who get this chemical into their bodies have a marked reaction, consisting of red, swollen face, red ears, stuffy nose and increased skin temperature on the face, after drinking alcoholic beverages. The reaction starts within 10 or 15 minutes after a half ounce of whisky and increases if more whisky is taken.

Discovery of the reaction and the chemical responsible for it was announced by Drs. William Lewis and Louis Schwartz of Washington, D.C.

Their medical detective work in turning up the new potential "cure" for alcoholism started when all the men on the second floor of a large printing company complained to the management about the unpleasant reactions they developed if they drank alcoholic beverages. Besides the blotched, red faces, the men were drowsy, short of breath and had palpitations. Because of these unpleasant symptoms, most of the men on the second floor stopped drinking.

The second floor was the press room, containing black and color presses. Careful investigation finally pinned the trouble to an anti-skinning compound in the inks, especially the yellow ink. Men at the ink manufacturing plant, it turned out, also had similar symptoms, especially when mixing yellow ink.

Need Fighting Drug?

➤ MAYBE WHAT this country needs is a good fighting drug, instead of tranquilizers and "happy pills" and anxiety relievers.

This idea, which could revolutionize drug treatment for the mentally sick and the neurotics, was suggested at a conference on pharmacotherapy in mental illness, sponsored by the American Psychiatric Association, the National Academy of Sciences, National Research Council and the National Institute of Mental Health.

Look for a drug which restores an animal's ability to fight back, it was suggested. Such a drug might be more useful than tranquilizers and euphoriants now given to make patients quiet and cooperative and to lift their depressed moods.

Instead of looking for more tranquilizers and euphoriants, medical science was asked to look also for something that will help a mentally sick person discriminate between what once was terrifying, but which need not be now that the patient is grown up and in a different situation than when he was a child frightened because he could not understand.

Such a drug should help the patient learn to enjoy going to sleep to rest instead of dreading it because of nightmares or looking to it for escape.

Since drugs are "screened" on laboratory animals to test their effects, one which enabled an animal to change its fixation at an immature stage of development might help a schizophrenic patient change his.

The drug that has an effect on only one patient out of 15 should be studied further instead of being discarded as useless. This very drug, even if it seemed at first to be a dud, could perhaps provide a mine of information about mental illness and new ideas for drugs.

A great difficulty in finding drugs to help the mentally sick is that scientists are looking for a cure for a condition whose cause is not really known.

Use Radiation to Make New Materials

➤ A MAJOR SEARCH for new materials formed by exposure to nuclear radiation is under way at the University of Michigan.

The radiation used is from radioactive fuel elements that are slowly losing their strength after being removed from Atomic Energy Commission's Materials Testing Reactor at Arco, Idaho. They are still very potent, and are the only ones in use outside government installations. Prof. Harold A. Ohlgren is supervisor of the Engineering Research Institute project.

The four elements, each two feet long, are stored under 16 feet of water in a well in the Phoenix Memorial Laboratory for atomic research.

As "used" fuel elements, they differ from the new, non-radioactive ones the University also received during the summer for installation in the Ford Nuclear Reactor this fall. Because they contain a number of important radioactive isotopes in highly concentrated form, the "used" elements also differ from a single-isotope Cobalt 60 source.

The fuel elements and a cobalt source can be combined to form one of the most powerful sources of radiation energy in the world.

Professor Ohlgren's group has set up equipment for piping chemical mixtures past the radioactive elements at various rates as the temperature, pressure and catalyst are changed. They plan to do this with the components of more than 250 chemical products to find out what happens.

Besides learning about the basic nature of these reactions, they hope to produce higher yields of useful chemicals at low temperatures and pressures, find new methods for economical manufacture of chemical products by ordinary means, and uncover totally new products.

The coupling of radiation energy with heat and pressure has prompted other engineering studies for power reactors which can be used by chemical and petroleum industries as nuclear heat sources.

It is believed that the potential in this field is so great that the use of nuclear energy and radiation might change dramatically the petroleum industry.

Hormones, Repellants and Antibiotics Reported

Chemistry In Agriculture

➤ FLOWERS that bloom in the spring, tra-la . . ." Well, some do and some do not.

But rare-bloomers and non-bloomers have been made to flower with the application of gibberellic acid, a new hormone-like substance.

This has been accomplished in experiments by Dr. Anton Lang of the botany department of the University of California at Los Angeles. It is the first instance in which flowering has been promoted consistently by chemical application and in a considerable number of plants.

Gibberellic acid has been known to Japanese workers for nearly 20 years but until recently has not attracted the interest of American and European plant scientists.

Dr. Lang applied the substance to plants that normally remain in a vegetative state indefinitely. Initial experiments were carried out on henbane, water pimpernell, sweet William, catchfly, carrots and other plants. Such plants normally form stems and flowers only under stimulus of cold or of long summer days. Otherwise they just grow leaves directly from the root crown or from a tuber.

Gibberellic acid caused stems to shoot up immediately and two or three months later the plants would flower, while untreated plants remained stemless and non-blooming.

Preliminary experiments by Dr. Anton Kofranek of the department of floriculture in application of gibberellic acid to hasten blooming of commercially important China asters have been encouraging.

Kill Weeds But Spare Crops

➤ CHEMICALS now spare the crop and spoil the weed.

Use of two groups of chemicals will mean that the farmer can control grassy weeds in his fields of broadleaf crops, such as peas, beans and radishes, as well as corn.

The prediction that selective chemical weed control will be possible in the "near future" was made by Dr. P. C. Hamm, project leader in charge of the herbicide screening program at the Monsanto Chemical Company, St. Louis, Mo.

The two groups of chemicals are N-substituted thioesters of dithiocarbamic acid and N-substituted alpha-chloroacetimides.

Modifications of these two chemical groups were used effectively to control germinating grass seeds of wild oats, rye grass and brome grass.

The results of the weed-killing tests show, Dr. Hamm said, that it will soon be possible to "tailor-make" a variety of weed-killers that will attack only the weed and save the crop.

Even more immediate, Dr. Hamm said, is the use of these same chemicals as tools for biochemists studying cellular chemistry. They could furnish practical means of controlling annual grasses in a variety of crops.

Disease Remedies from Seeds

➤ ANTIBIOTICS, or so-called mold remedies for germ diseases, may in future come from the germinating seeds of various plants.

One potential antibiotic has already been isolated from a common garden plant called the red hot poker.

This is reported by Dr. L. Ferenczy of the University of Szeged, Hungary.

He has tested seeds not more than a year old of 400 varieties and species of higher plants belonging to 70 plant families for ability to stop the growth of such test organisms as Bacillus subtilis, Staphylococcus aureus which is found in boils, and a member of the dysentery germ family, Shigella flexneri VI. Included in the seeds tested were juniper and geranium seeds.

Certain seeds generally known to contain anti-bacterial substances did not check the bacteria in the tests because the active compounds are located in the inner parts of these seeds. It usually takes ferments to release them, which Dr. Ferenczy did not use in the tests he reports.

The anti-bacterial compounds he found are almost all localized in the seed coats.

Better Insect Repellents

➤ BETTER INSECT repellents should come through a discovery of Dr. R. H. Wright of the British Columbia Research Council, Vancouver.

Incidentally, scientists will no longer have to test repellents by letting mosquitoes or other insects feed on their arms to see whether or not the repellent actually repels.

Chemicals do or do not repel mosquitoes and probably other insects according to the low-frequency fundamental vibrations of the molecules of the chemicals, Dr. Wright finds.

The molecular vibration can be determined from the chemical's absorption of infrared light. Those chemicals with infrared absorption of a certain pattern repelled mosquitoes. Others of a different pattern did not. The only exception found was dimethyl phthalate, a well-known repellent. Its structure probably explains this.

Besides giving a physical test for mosquito repellents and a clue to the kinds of chemicals to make and test, Dr. Wright's discovery lends support to the theory that the low-frequency vibrations of molecules provide the physical basis of their odors. Such vibrations may be able to trigger nerve discharges so that the sensation of odor reaches the brain.

Marine Borers Riddle Lead

➤ MARINE borer mollusks are now known to attack lead as well as wood, fibers, rocks and shells that they usually riddle with troublesome holes.

Damage to lead-sheathed submarine telephone cable in service since 1927 in the Ortega River, Jacksonville, Fla., was traced to the mollusks of the Pholadidae family, in an inquiry by L. R. Snoke of Bell Telephone Laboratories and A. P. Richards of William F. Clapp Laboratories, Duxbury, Mass.

For The Home Lab

Methylene Blue

by Burton L. Hawk

➤ The preparation of Methylene Blue presents a mild challenge to the home chemist. Although rather involved, the preparation should present no great difficulty if instructions are carefully followed. In order to facilitate matters, the process has been broken down into separate steps in real "do-it-yourself" fashion. You can check off each step as it is completed. Again, we stress that instructions be followed most carefully. Particular attention should be paid to quantities used and temperatures designated.

☐ 1. The first step involves the preparation of starch-iodide paper which will be needed to test the reaction. Mix about 2 grams of ordinary starch with about 25 cc. of water in a mortar. Grind the mixture with the mortar until a smooth suspension is obtained—free from lumps. Pour the mixture slowly, with stirring, into 200 cc. of boiling water. Stir for a few minutes and allow to cool. When cool, mix a portion of this solution with an equal quantity of potassium iodide solution. Soak several sheets of filter paper in this mixture for a few minutes, then allow to dry.

☐ 2. Preparation of nitrosodimethylaniline. Dissolve 5 cc. of dimethylaniline in 12 cc. of concentrated hydrochloric acid. Add 25 grams of cracked ice to the solution and insert a thermometer. Stir until the temperature reaches 0 deg. Dissolve 2½ grams of sodium nitrite in 10 cc. of water. Slowly add this solution to the iced mixture, a few drops at a time. Stir rapidly after each addition. Do *not* allow the temperature to rise above 5 deg. during this addition. If necessary, more ice may be added to keep the temperature down. The mixture will turn yellow immediately and will gradually darken to a deep orange. After all the nitrite has been added, withdraw a small sample of the liquid and dilute it with 3 volumes of water. Test this solution with the starch-iodide paper prepared in step 1. The test should indicate the presence of free nitrous acid, which will color the paper blue. If the test is negative, more nitrite solution must be added until the blue color is obtained. Proceed exactly as outlined above; add only a small quantity of nitrite, then test again. Remember to keep the temperature below 5 deg. This is important!

After a positive test reaction is obtained, the entire solution is allowed to stand for two hours. At the end of this time, yellow crystals of nitrosodimethylaniline will separate out.

☐ 3. Preparation of p-aminodimethylaniline. Our next reaction consists of reducing the nitrosodimethylaniline mixture. Stir the latter vigorously and add 25 cc. of water. Start the reduction process by adding 20 cc. of concentrated hydrochloric acid and 5 grams of iron filings. This time it is necessary to keep the temperature below 30 degrees. So add sufficient cracked ice to maintain this

temperature. Stirring frequently, allow the solution to stand for a short while. After this time, extract a few drops of the solution with a medicine dropper and allow a drop to fall onto a clean piece of filter paper. When the spot on the filter paper is colorless, the reduction is complete. If your spot is yellow, then continue the reaction. If necessary, more iron filings and hydrochloric acid may be added. Continue to test from time to time until the solution does not color the filter paper.

☐ 4. Neutralization is next. Partially neutralize the solution with calcium oxide, or lime, then finish the job with precipitated chalk (calcium carbonate). The carbonate is added, a small quantity at a time, with stirring after each addition, until all frothing ceases. Finally, filter off all the lime, carbonate and iron filings. Keep the clear filtrate.

☐ 5. The following several steps are performed quickly one after the other. In order to be ready it might be a good idea to prepare the solutions needed in advance, as follows: Solution A—Dissolve 8½ grams of sodium thiosulfate in 10 cc. of water. Solution B—Dissolve 13 grams of potassium bichromate in 30 cc. of water. Solution C.—Dissolve 4 cc. of dimethylaniline in 6 cc. of concentrated hydrochloric acid. Solution D. —Dissolve ½ gram copper sulfate in 5 cc. of water. If necessary, the solutions may be heated to completely dissolve the solids, but be sure to cool again before using.

☐ 6. Shake the clear filtrate from step 4 vigorously. Add solution A (sodium thiosulfate), shake again, and proceed immediately to next step.

☐ 7. Add one-half of Solution B (potassium bichromate) in small portions over a period of several minutes. Shake after each addition. Allow the mixture to stand for an additional two minutes before proceeding to the next step.

☐ 8. Add all of Solution C (dimethylaniline), shake, and proceed immediately to next step.

☐ 9. Add the second half of Solu- B (potassium bichromate), again in small portions over a period of several minutes. This time, continue stirring and shaking the solution for an additional five minutes before proceeding to the next step.

☐ 10. Add Solution D (copper sulfate) and shake again.

☐ 11. Transfer the mixture to a large flask and apply gentle heat. Gradually increase the heat until the mixture just begins to boil. You will note the mixture takes on a bronze copper-like appearance. If excessive frothing occurs, discontinue heating until it settles down, then re-heat. You may have to repeat this several times before the liquid boils.

☐ 12. The hot solution is now filtered. The black precipitate is washed with hot water. By now you will notice that the filtrate is an intense blue color. This is due, of course, to the methylene blue. To separate it, proceed to the next step.

☐ 13. Heat the filtrate to 80 degrees. For each 25 cc. of solution you have, add 4 grams of common salt and 2½ cc. of hydrochloric acid. Allow the solution to cool. Methylene blue will separate in fine crystals.

Methylene blue is a type of *thiazine* dye. It is a beautiful shade of blue and

is used for dyeing cotton. It is also used as a stain in bacteriology.

We seem to have arrived at exactly 13 steps for this experiment. This will never do. So to break the spell, suppose we add another step:

☐ 14. Wash the glassware and clean up the mess.

Fight Fire With Soda

➤ A GOOD SAFETY precaution in case of fire is to keep a package of baking soda by your kitchen range. Use it if you have the dangerous experience of having grease catch fire while you are cooking. Scatter the baking soda on the burning grease. The soda absorbs the grease and gives off carbon dioxide to suffocate the fire. Another way to handle a fire on the stove is to put a tight lid on the pan, thus smothering the fire.

Do not use water on burning grease. This may only spread and scatter the fiery grease and make a small fire much worse.

Firefighting is generally considered a man's job. But many women and children are injured and killed each year in home fires. So the housewife needs to know how to prevent tragedies.

Fire extinguishers are useful in the home. Here are some suggestions about their use:

For class A fires—that is, burning paper, cloth, wood or household rubbish. Wet down to remove heat. A five-gallon pump tank kept filled with water and in a convenient place is good for quenching such fires. Also recommended is a soda acid extinguisher.

For class B fires—burning oil, grease, paint or gasoline. The foam extinguishers are excellent for this type of fire.

For class C fires—electrical equipment. These call for smothering with some substance that does not conduct electricity. The carbon dioxide extinguishers and the dry chemical extinguishers both are excellent for this type of fire.

Soda acid and foam extinguishers must be kept where the contents will not freeze.

Computers Use Honeycomb Device

➤ SMALLER electronic computers with larger "memories" are expected when an inch-square honeycomb device that will store up nearly a million bits of information is used.

Heart of the information storage tube, developed by Dr. Harold R. Day of General Electric Research Laboratory, Schnectady, N. Y., is a thin sheet of glass in which small holes have been etched and filled with metal. Information written onto one side of the honeycomb by an electron-beam scanning method similar to that used in television is picked up from the opposite side.

Holes in the honeycomb are 500 to the inch, so each square inch has 250,000 individual storage cells — and each cell will recognize at least 10 different levels of intensity from the writing gun.

Industry Can Afford Basic
And Fundamental Research

Journeys in Research

by Dr. Edgar C. Britton

Excerpts from the 1956 Perkin Medal address at the time of the Perkin Centennial at the Waldorf-Astoria Hotel, New York before The Society of Chemical Industry.

➤ How like an exploration into the unknown by a traveler and his company is a journey in research. The provisioning for the journey, the study of known facts before the journey, the desire to keep going until the objective is reached, the return journey and reports which will permit others to develop the area explored are so similar for each type of endeavor. Even the results are the same since each hopes to open up an area of use to man. And how similar they are when the traveler and explorer must convince those who sent him that he has really discovered an area that should be commercially developed, and with what trepidity do the sponsors approach this development, unless much, much gold can be shown in the area.

The first prerequisite and a part of a journey in research is exploratory research, which shows whether or not a complete journey in research can be undertaken. After exploratory research, the decision must be made as to whether a journey shall or shall not be continued. How and by whom this decision is made varies in different companies, but ideally the decision should be made by one who can supply not only the physical means for the journey but the spiritual and inspirational needs as well. This one should also be in a position to decide when the journey shall cease so that the explorer can return to home base, as it were, to prepare for another adventure in research. It is my opinion that those who conducted the exploratory research should be a part of the team that makes the complete journey in research. However, since there are so many different skills required they alone cannot make a proper journey. After a few journeys the traveler and explorer knows more and more about how to make a successful journey and so it is with "Journeys in Research," several of which I will proceed to describe . . .

In 1940 at the behest of Dr. Willard Dow I went to Corning to meet with the chemists of Corning Glass including Drs. Sullivan, McGregor, Hyde and Warwick to discuss what they had discovered about the chemistry and uses of organo silicon compounds. I reported back to W. H. Dow that this was truly a field of chemistry with a great future and one where Dow's raw materials could find large use. I will not elaborate on the formation of the Dow Corning Corporation or its accomplishments which was amply related last year at the Chemical Engineering Award dinner. Although our organic laboratory ran the first semiplant of silicon insulating resins, the greatest credit goes to W. R. Collings and his colleagues

who worked on the methyl fluids. My only comment on this journey was that we could not retrace the short paths which had been opened up by the early published work of Dr. Kipping and others, which led us nowhere. Until a great deal of road building in the chemistry of high polymeric silicones was accomplished no progress could be made. The control of these polymerization processes and the manufacture of the raw materials for polymerization is the core of the silicone industry.

Another journey of considerable length and in which we are still engaged is emulsion polymerization. We started in the area of emulsion polymerization of vinylidene chloride, vinyl chloride and styrene. We soon discovered that we knew and others knew very little about emulsion polymerization especially regarding the effect of variables in the polymerization on the characteristics of the final product, be it an emulsion for sale or a coagulated polymer. It took us two years of steady work to fix these effects, but the time spent was well worth the effort since at the end we were able to predict these effects from mathematical formulas worked out from the results obtained. It seems that in certain areas of research, a slow, steady accumulation of fundamental data is necessary for continuing progress; otherwise only sporadic, short and inconsequential journeys can be made. The results of such short journeys are hard to relate to the others. In industry, if we intend to develop an area, the fundamentals of chemistry in that area should be and can afford to be worked out. In other words industry can afford basic and fundamental research in areas of chemistry where large amounts of their capital are invested.

Early in World War II the Dow Company, like many chemical companies, became interested in producing butadiene. We had an azeotropic ammonia distillation process developed to a plant scale for separating butadiene from butylene, the raw material being the C_4 cut from our hydrocarbon cracking plant. We had worked with U.O.P. to try and develop their dehydrogenation process, but this project failed through mechanical difficulties. However, we were still interested in a catalyst for dehydrogenating butylene to butadiene hence another journey in research. In the area of catalytic work it is generally conceded that luck is a partially determining factor. If that be the case we had all the luck possible. After considerable study we decided to take tricalcium phosphate as our catalyst base. In its crystalline form it is a trimer molecule, being $Ca_9(PO_4)_6$. We decided to coprecipitate nickel in the molecule so as to come out with an approximate formula $Ca_8Ni(PO_4)_6$. We certainly were fortunate. The first preparation we made and used proved to have good activity. We later found that the catalyst so prepared had a rather short life which could be extended considerably by the inclusion of Cr_2O_3. It will dehydrogenate butylene with as high as 90% yield of butadiene. It will dehydrogenate ethylbenzene to styrene. This catalyst will not function properly unless a large ratio of steam to hydrocarbon is used to supply the heat necessary

for the dehydrogenation as well as provide water, as we believe, for the absorption of the unsaturated hydrocarbon on the catalyst surface. The carbon deposited on the catylist must be burned off after each dehydrogenation to restore it to its original effectiveness. It is significant that in the commercial promotion of this catalyst in the United States we had considerable disappointment, until the synthetic rubber business was removed from government control.

Another journey on which we started several years ago and which we haven't finished is in the field of synthetic alpha-amino acids as found in proteins. In 1935, Dr. Rose of Illinois reported that eight of the amino acids found in good protein were essential for humans, that is, not one of these eight amino acids if absent from the diet could be synthesized by the human body from any materials ordinarily ingested in sufficient amounts to sustain life. These eight essential amino acids are methionine, phenylalanine, tryptophan, lysine, leucine, isoleucine, valine and threonine, and all must be in the diet in order to sustain life. For white rats arginine and histidine must be added to this list and for avian species glycine must be added. It has been supposed that these exotic chemicals would always be high priced and many of them are still high priced, but syntheses are now developed so that, with large production, these amino acids can be cheap enough for everyday use. When we have a meat dish as we have had tonight we don't have to worry about our essential amino acids for this day. This meat should be going through the process of digestion which breaks it down into free amino acids, and these travel to the tissues to replace those broken down by our efforts to get here, digest the food and bear up under the barrage of speeches that we have had to endure. If large production of these amino acids were available we could probably supply all your daily requirements by feeding you about 80 grams of the mixture and at large production prices this wouldn't cost you more than $1.00. However, one would surely have to be a Spartan to forego such delectable food and substitute part of it by a bland sweet tasting mixture of these essential amino acids. There may come a day, however, when some of us "sans teeth, sans taste, sans eyes, sans everything" will be glad to have such a mixture to supply our daily proteins. Seriously, though, the supplementation of cheap proteins by certain of these essential amino acids should be thought of as necessary to animal husbandry and national health as is supplementation of our food with vitamins.

This journey has just begun and we are not sure of how large a road to make or in what direction to start it; the surveys are not all in and the rivers to cross and the grades to be climbed are not all known. However, it is a journey that must be completed for the good of chemistry and of the human race. The implications of this journey are beyond realizing at this time.

During all these special journeys, a few of which I have mentioned, is the continual journey proceeding to the use of synthetic organic compounds in industry, agriculture and medicine. This looking for uses for

compounds applies to a wide range of testing and it is my observation that a good screening test designed to separate the good from the bad is absolutely essential. Indeed the present day progress of chemistry in providing the world with better insecticides, fungicides, detergents, plastics, rubber, synthetic fibers, medicines and the like has all depended on better screening and testing methods than were formerly available. I want to pay my tribute to those who develop, operate and interpret these tests, for without them industrial synthetic organic chemistry would be pointless. My thinking along this line is very positive. I believe the chemist was put on this earth to provide materials for man's use. If every chemist had this thought in mind, be he teacher or researcher, and made it part of his idealism, our progress would be astounding. How often have men synthesized compounds, set them on the shelf and later these materials were proven of value to the people. DDT, Lindane, p-aminosalicylic acid, sulfanilimide are but a few. DDT was discovered in 1874 and was never tested until 1939 as an insecticide. What an appalling waste of material and of human life took place in the interval between discovery and use. We still have chemists who satisfy their professors by preparing chemical compounds in amounts of 50-100 milligrams each as a requirement for their doctoral thesis. When you speak of such waste of a chemist's time in preparing such small amounts as to be practically useless, they reply "you in industry can prepare larger quantities if you want them for testing," thereby assuming that industry should become the benefactor of the human race, forgetting as they do the benefit that would result if they had good liaison with medical schools, agricultural schools and engineering schools. The cult of our researchers who proclaim "knowledge for knowledge sake alone" as the greatest good should be eliminated and excluded from our institutions of learning. The least one can do is to hope that the results of his work will be useful to mankind at some future time.

I have always considered myself a scientist, and in all questionnaires classify myself as a chemist. I think and feel like Pasteur when he said in Orleans in 1867, "Nothing is more agreeable to a man who has made science his career than to increase the number of his discoveries, but his cup of joy is full when the result of his observations is put to immediate practical use." How much more glorification for science is this than "knowledge for knowledge sake alone."

Early in my journeys I found that The Dow Chemical Company could not well afford to spend a large amount of money in an area in which anyone who wanted to do so could place a claim. In order to stake out the claim in proper manner, it was necessary to apply for patents, hence at, of or during our journeys in research a great deal of time has been spent in applying for these letters patent so that products and processes could be worked on without interference by others. This activity in the patent field should be regarded as part of a journey in research and indeed in some cases is the very best reason for making a journey.

Electronic Light From Treated Glass Area Demonstrated

Electroluminescence Lights Room

➤ A ROOM lighted by electroluminescence was demonstrated in connection with the dedication of Westinghouse's new multimillion dollar research laboratories erected near Pittsburgh.

Panels no thicker than window glass lining the ceiling and three walls, give off light of approximately 50 foot-candles, equivalent to that in a modern well-lighted office or class room.

One hundred and twelve glass panels, each one foot square in size and giving off a soft green light, are used to illuminate the room with shadowless light. Walls and ceiling of the room are not lighted, but give off light, creating light without conventional light fixtures.

The housewife of the future may have control over the lighting in her house through electroluminescence. Two knobs will be in every room, one for brightness and the other for color.

These will adjust for any level of brightness, and, even more important, will create any color atmosphere, from varying shades of white, to blue or red.

First discovered in 1936 by Georges Destriau, French scientist and Westinghouse lamp division consultant, electroluminescence is the giving off of light by phosphors coated on a glass panel that is treated to conduct electricity. When electricity is applied, the panel lights up.

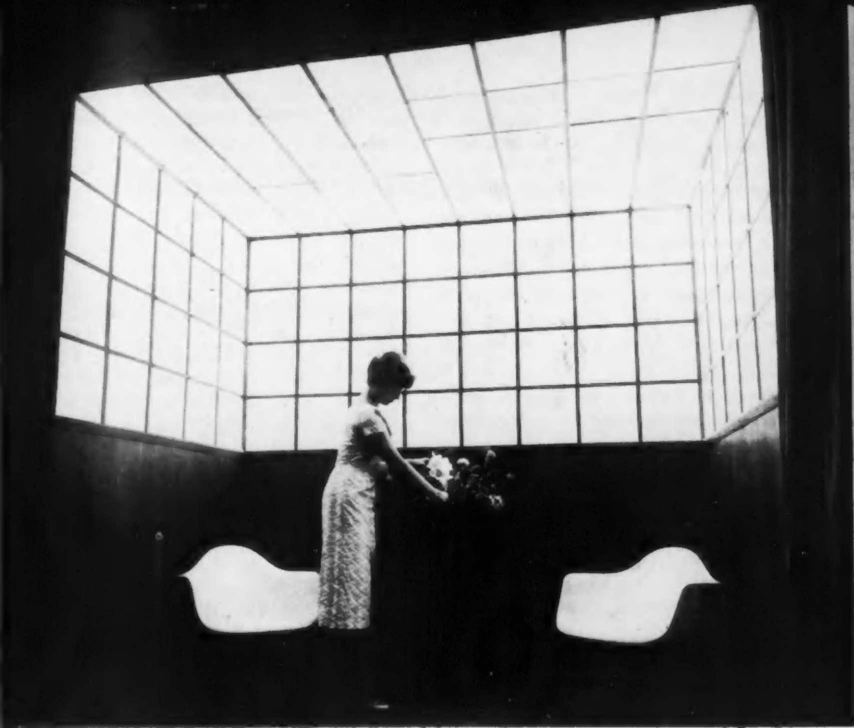
Because the efficiency of electroluminescence is not yet up to present-day light sources, widespread use is not yet economically feasible. Edward G. F. Arnott, lamp division director of research, foresees that if progress continues at the rate it has during the past two years, practical everyday electroluminescence should not be very far off.

"In its early days, electroluminescence was a laboratory curiosity," Mr. Arnott recalled. "You had to turn out all the lights and adapt your eyes to the darkness before you could see its faint light. Now we have panels that are brighter than fluorescent lamps."

An electroluminescent flashlight has been made. No larger than ordinary ones, this flashlight is powered by a 25-volt battery and contains a special transistor circuit to provide the type of electricity needed. No light bulb is used; instead, a small glass disc gives off a blue colored light. A transistor circuit changes the d.c. to 550 volt, 8500 cycle a.c.

What makes electroluminescence so promising as a light source is the high upper limit of efficiency that could be reached. This efficiency limit is four times as high as that of today's fluorescent lamp, and more than twice that of the best fluorescent lamps of tomorrow.

Electroluminescent cells are of various colors. Besides white these in-



➤ THE WORLD'S FIRST ROOM *with walls and ceiling made of light. Panels no thicker than window glass line this room, providing light from man's newest and most promising light source, electroluminescence.*

clude the colors blue, green, orange, and red. One cell in particular was made to change through all four colors by varying the character of electricity applied. Employed on a large scale, this principle would permit changing the lighting of a room to any shade of white, merely by turning a knob. Psychologically, this would have its advantages: hot days might appear cooler by using a bluish white; drab and dreary days might be "warmed" by changing the light to a reddish white.

Freeing light from the confines of point and line sources such as incandescent or fluorescent lamps, electroluminescence promises to give new concepts of lighting. Light in the future will be part of the construction of walls, ceilings, and possibly even floors. And, because electroluminescence is not resricted to flat planes, light may go into the construction of domes, balustrades, and other architectural designs.

Speculating on what living with electroluminescence will feel like, Mr.

Arnott said, "Imagine a living room that is as cheerful and bright as a summer landscape, without consciously being so; that is, with no apparent, concentrated source of light. Visualize a modern factory, completely conditioned to the psychological well-being of its employees, with light conditioning provided by an even glow emitted by the walls and ceilings. And with electroluminescent cells taking on a wide variety of shapes to suit various lighting needs, perhaps we shall see the vented hood over the kitchen range helping to illuminate the room. Or, the glass shower stall door might provide light for the bath, with perhaps just a bit of special phosphor thrown in to serve as a healthful sun lamp."

Electroluminescence is light emission by suitable phosphor powders embedded in an insulator and subjected only to the action of an alternating electric field.

The panels lighting the demonstration room are sandwich-like in construction: a $\frac{1}{8}$ inch thick, one foot square glass plate is coated with a transparent, but electrically conducting film. Over this is spread a thin layer of polyvinyl chloride plastic in which is embedded a zinc sulphide-type phosphor. Topping it off is an aluminum conducting coating. The panel thus resembles a capacitor, with two conducting layers separated by a dielectric. Electricity applied is 350 volt, 3000 cycle a. c. Brightness of the panels is 100 foot lamberts and efficiency is 3 lumens per watt.

Drugs Control High Blood Pressure

➤ A NEW series of drugs built to order to control high blood pressure are expected to result from new research.

One such drug, BAS, has already been synthesized and found to reduce blood pressure of patients with hypertension. Only small doses were needed, and these did not seem to cause harmful side effects, Drs. D. W. Woolley and E. N. Shaw of the Rockefeller Institute for Medical Research, New York, have found. The clinical trials of BAS were made in cooperation with Dr. Robert Wilkins of the Massachusetts Memorial Hospital.

Chemical name of BAS is l-benzyl-2,5-dimethyl serotonin. It is related to serotonin, a natural body chemical found in blood serum, and was devised to block serotonin's action in the body.

In designing the anti-serotonin drug, Drs. Woolley and Shaw had to make it effective when taken by mouth, with a low inhibition index and not reversible in its action, and lacking in effect on the central nervous system. Early investigations of antiserotonins showed some of them affected mental processes. BAS is called an antimetabolite because it acts antagonistically to the hormone serotonin.

Further experiments with other antimetabolites blocking action of other body chemicals may yield drugs for treating both infectious and noninfectious disorders.

Atomic Ships Will Submerge In Rough Weather

Atomic Power for Merchant Fleet

➤ MERCHANT shipping is going atomic. Atomic scientists taking a long look into the future came up with this picture of tomorrow's merchant fleet:

1. Fishing vessels will be floating factories. All the steps involved in processing, including the new atomic method of food preservation by irradiation, will be carried out aboard one big ship which will remain at sea all year. The finished products will go straight from ship to market.

2. "Mining ships" will drill for oil on continental shelves far from their sources of fuel and supplies. There may be less reliance on Middle Eastern oil fields.

3. Rough weather will not be a cause of seasickness on tomorrow's atomic vessel. Ships will simply submerge beneath the waves into the undisturbed subsurface waters. Today's large vessels are unable to do this because conventional fuels require oxygen.

4. Icebreakers will be able to smash through Arctic ice packs without making the long return voyage for supplies each fall. They will be able to remain locked in frozen northern waters all winter if necessary, because space which would be used for fuel today can be used for food tomorrow.

5. The merchant ships of 1980 may be much faster than those of today. Scientists say no one knows the limits of an atomic ship's speed.

6. The ships will be larger and will therefore require larger canals.

The scientists based their predictions on the known advantages of atomic power. Atomic ships will be able to go one to two years without refueling. Fuel will take up less space. The larger the atomic reactor, they point out, the more economical it is to operate.

The pioneer atomic ship may be either a large tanker, a dry cargo ship or a combined cargo-passenger vessel. No definite type of reactor has been decided upon, but scientists say the quickest to build would be a pressurized water system similar to that used on the atomic submarine, Nautilus.

The Atomic Energy Commission is considering about 20 other types of reactors.

Diamonds Studied in College

➤ DIAMONDS are being studied at the Illinois Institute of Technology. The precious stones are not primarily jewels, but diamonds used for cutting, sawing and boring because of their great hardness.

Work concerns the preparation and use of diamonds as industrial tools.

Part II of An
Anecdotal Reminiscence

Petrochemical Survey

by J. G. Davidson, *Vice-President Union Carbide and Carbon Corporation*
An address before the American Section, Society of Chemical Industry upon the occasion of the presentation of The Chemical Industry Medal.

➤ We now come to the story of Vinylite. That started in a curious way also. At that time, tung oil was used very extensively in varnishes because the varnishes so made would dry hard and would not turn white when boiling water was spilled over them. However, the supply of tung oil was erratic, the price was variable and, in addition to that, people working with it were subject to a rather severe skin disease. So, one time when I was discussing the situation with a salesman for a varnish company, he asked why shouldn't it be possible to make a synthetic tung oil. That started a train of thought that caused me to look up the composition of tung oil and, sure enough, I found it contained a number of vinyl groups.

Well then, I looked up the literature and found that vinyl chloride could be produced from ethylene dichloride of which we had a super-abundant supply at the time. It could also be made from hydrochloric acid and acetylene of which we also had a plentiful supply. So, we made some vinyl chloride and polymerized it. We got a white solid that could be formed into objects but our first experiments were very disheartening. A plaque of Vinylite put on the roof and exposed to the sun would turn jet black in an hour or so and become as brittle as a thin piece of charcoal. It was a long time before we learned how to incorporate plasticizers and produce a copolymer of vinyl chloride and vinyl acetate, which was the first product we called Vinylite.

Just as so often happens, we tried to substitute it for known resins, Bakelite phenolics, for example, but in comparison with these, it was no good at all. We sent a sample of it to the Bakelite Company, which then was not a part of Union Carbide, and they returned it with the notation that it was of no interest because upon boiling in water, it was reduced to a gummy mass. It had no dimensional rigidity under stress and generally was not like the Bakelite phenolic resins; therefore, obviously no good. Its properties were not similar to the other two resins that were available then; namely, cellulose nitrate and cellulose acetate, and we became quite discouraged.

However, about that time somebody had the bright idea of molding toothbrush handles from it so we bought a few injection molding machines and molded up thousands of toothbrush handles. Here, we were within fingertip reach of success but the toothbrush handles were found to be lacking in one respect. As you probably know, the tufts of bristles

are inserted as a part of a high-speed drilling operation and the Vinylite resin softened to the point where it gummed up the drills and slowed down production; therefore, Vinylite was unacceptable because it took longer to process even though when you finished you had a good toothbrush handle.

Vinylite Dentures

Thinking of teeth, of course, brought us in contact with the dental people and for a time we supplied Vinylite resin plaques for the manufacture of dentures for false teeth. This was an excellent business for although the volume was small, the price was excellent, something like $5.00 a pound. But here again, we ran into difficulties.

In 95% of the cases, the vinyl dentures worked out perfectly and were far superior to the materials that previously had been used but in the case of people who had a high roof to their mouths, a high palatal surface it was called in the dental surgeon's lingo, the vinyl denture would flex a little at each closing of the jaws and finally, through fatigue, would crack right down in the middle and curiously enough these dentures always seemed to pick out the most embarrassing moments to split. I remember one time when our good old friend Charlie Parsons was making a speech. He became so enthusiastic that he gritted his teeth and at that precise moment his denture split right down the middle and, since he had no spare with him, that was the end of the speech.

A few more instances like that and we included ourselves out of the dental field but fortunately during this time new uses began to develop in other directions.

One of our superintendents at the South Charleston plant in his off-time began rolling out sheets of plasticized Vinylite resin, cut them into strips and made some belts and suspenders for himself and for other people around the plant. Finally, we in New York became interested and tried to sell the idea to the belt manufacturers but the established ones would have no part of it at all.

A small concern in Chicago, however, took up the idea and shortly vinyl belts and suspenders became the rage. We sold what we in those days considered prodigious amounts of Vinylite, amounting to some hundreds of thousands of pounds and Vinylite belts were seen everywhere. I still wear them and I think they are the best belts that can be made. But then we ran into a definite merchandising difficulty. All of the large and reputable manufacturers who had come into the fold by that time, put out a good belt that sold for $1.00 to $2.50 but pretty soon, since not very much equipment was required, smaller firms who were only interested in making a fast buck got into the business and they began cutting the quality of the belts, making them thinner and narrower until they became mere strings and it finally got around to the point where you could buy an inferior belt for $0.25 to $0.50. At this point, there was no profit in it for the haberdashers who therefore refused to carry them any longer and Vinylite belts went into an eclipse. Now they are coming back again because the only people interested in

manufacturing them now are those who produce belts of good quality.

After all these difficulties in getting started, we finally found ourselves in business. Vinylite raincoats came along next, then Vinylite records, sheeting, then insulation for electric wires and cables, then Vinylite inflated toys and equipment and finally, after we had proven the product, competition reared its ugly head. All of the rubber companies, one by one, went into the manufacture of vinyl resins of one type or another, then other companies followed them, until as an actual matter of fact, there are today nine companies manufacturing vinyl resins in one form or another and that does not include the firms that only compound or fabricate the product. But the interesting fact is that production has now reached the astonishing total of 550,000,000 pounds per year and is still growing very rapidly.

Our interest in Vinylite quite naturally made us think of synthetic fibers made from vinyl resins so we started out to make some. At first, we used the same copolymer of vinyl chloride and vinyl acetate that we had been using for other purposes. The fiber was called "Vinyon." Our results with "Vinyon," however, were not very satisfactory and later on we changed the composition of the fiber drastically, replacing the vinyl acetate with acrylonitrile and changed the name to "Dynel." The properties of this fiber were very different. It had a much higher softening point, a softer "hand," and the spun fiber had a different appearance resembling that of wool. Cut into staple and twisted into a continuous fiber, it had an excellent reception at a time when wool was selling at $2.50 to $3.50 a pound. But shortly afterward, the wool market broke badly and it began to be difficult to sell Dynel for those uses in which it displaced wool, such as sweaters, blankets, etc. But frequently there is a happy ending to these hardship stories. Several people, particularly one man, who had had experience in many unrelated fields (such as president of a company making automobile clutches, ranching, hotel and a bankrupt textile company—his name, by the way is George W. Borg), noted that Dynel when made up into a pile fabric had some of the characteristics of certain furs. At first, the fabric was jokingly referred to as "fake fur."

Fur-Like Fabrics

These fur-like fabrics were first purchased by the Army for collars for aviators' jackets, liners for parka hoods and jackets. Due to manufacturing difficulties, these military goods were knit from a blend of Dynel and another synthetic fiber (Vicara). As manufacturing experience was gained, Dynel was used 100% in the pile, which improved the appearance and wear life, and closely resembled mouton, but had many advantages over the real skin. Shortly it became obvious that now we really had something where Dynel could stand on its own feet and its own properties.

At this stage of development, the fabric had a cotton back, which was rubberized, with the Dynel only in the pile. This fabric was suitable for collars, but was too heavy and had a poor drape for coats. Again,

Dynel became important when it was found by Borg that if Dynel were used in place of the cotton backing, that it could be stabilized by heat, and the use of the latex on the back could be discontinued. By this change, a lighter fabric with excellent drape was produced.

To make a long story short, these fur-like fabrics are now in great demand to make the new Borgana and O'llegro coats. They have all the warmth and beauty of a fur coat but only about two-thirds the weight, and sell at a fraction of the price of a fur coat. These coats have better wearability, they drape much better than fur and generally serve the purpose and have much better appearance than medium-priced furs. A large portion of the production of our Dynel plant is going into this use now.

In any event, the American public is getting a wonderful, warm, light, fur-like coat for a very modest price.

Polyethylene

We next come to polyethylene. This was a war-time product. The Imperial Chemical Industries of England were the ones who first discovered and patented the process for polymerizing ethylene. They in turn licensed the process to the du Pont Company. About this time, we found we had some high-pressure equipment standing idle and did some experimenting of our own with ethylene and found we could produce polyethylene by a somewhat different process but one still subject to the I.C.I. patent. During the war we were asked, along with the du Pont Company, to produce polyethylene, primarily for radar cables. Just in case you do not remember, radar cables were cables that ran up the mast of a ship encased in a tube containing a gaseous dielectric, such as nitrogen or air. An exploding shell nearby—even the firing of the ship's own guns—often shattered the tube and rendered the radar inoperative. Polyethylene was found to have the dielectric properties needed but in solid form and was thereafter used as insulation for the radar cables.

We finally obtained a sub-license from the du Pont Company although as I said before, our process was somewhat different from theirs. We used very considerably higher pressures, amounting to as much as 30,000 pounds per square inch and, in the initial phase of our experiments, we consumed more pounds of steel than we made pounds of polyethylene. By this I mean we wrecked more pounds of pumps, primarily pump cylinders and pistons, than we produced polyethylene but little by little, these difficulties were overcome.

After the war, the use of polyethylene began to grow enormously. It was found to be superior to all other materials for insulating high frequency electric wires and cables. Polyethylene sheeting was used to make bags for use in the deepfreeze, for sealing equipment against moisture and finally pipe—both flexible pipe and rigid pipe—began to be manufactured from polyethylene and the market has continued to grow enormously. The termination of the Government's suit against Imperial Chemical Industries and du Pont made licenses available to all under reasonable terms and there are now 7 firms manufacturing approximately 350,-

000,000 pounds of polyethylene per year in the United States and this does not take into account all the firms compounding or fabricating the polyethylene nor the additional firms that have taken out licenses and are building plants. Within a few years, however, the producers will number at least 12 and the capacity will be 800,000,000 pounds per year.

And now to complicate the picture still more, two new processes have been developed, one in Germany and one in the United States, which produce a somewhat different variety of polyethylene. One of these, the Ziegler Process, operates at atmospheric pressure while the Phillips Petroleum Process uses moderate pressures of 250 to 500 pounds. The variety of polyethylene produced by these processes will stand considerably higher temperatures without deformation than the older type but we believe they will be somewhat more expensive to make.

Each variety of polyethylene will find a market, I am sure, and the older high-pressure type will hold its position, I feel certain, because it will be cheaper and for all of the uses for which higher softening points are not required it will serve every bit as well and possibly better than the new varieties. Again, this illustration shows that in our industry nothing is ever quiescent for long. Just as soon as somebody produces a new and interesting material, somebody else starts out to improve its properties or work out different methods of making it. Competition, I am quite convinced, is a good thing. It keeps you on your toes and makes you work as hard as, or harder than, your competitors to improve your products or processes. In the case of polyethylene, none of the producers of the high-pressure product thought of the new or low-pressure process. On the other hand, the inventors of the two new processes did not start out to make polyethylene. They were looking for other things but they were smart enough, both of them, to recognize the adaptability of their process to the production of polyethylene. So, now we have more competition and I welcome it. In the end, it will be good for the product, for us and for you, the final consumer.

If we had not had competition both for Vinylite and polyethylene, the quality of neither product would be as good as it now is and the production volumes would be nowhere near the present astronomical totals they have already attained.

Butadiene

The history of butadiene is also of interest. So far as we are concerned, it goes back a long time. When we cooled the gases from the cracking furnaces down so they could be separated by the Linde Process of low temperature fractionation, we always obtained a fair quantity of a liquid product that was foul-smelling and impossible to do anything with. Since it was collected in our drip pots, we called it by the very descriptive and onomatopoetic and unappetizing name of "Dripolene." By very careful fractionation in the laboratory, however, we discovered that it contained a lot of quite valuable materials; such as, benzene, toluene, xylene, and also substantial quantities of butadiene.

At that time, the benzene, toluene and xylene were the only valuable

constituents in it and we tried all the then-known operating processes to separate them. That process you may remember constituted the addition of concentrated sulphuric acid to the slightly similar by-product liquids from the coke ovens which addition would polymerize the small amount of unsaturated compounds present which would then very agreeably settle to the bottom of the vessel and permit the benzene, toluene and xylene to be decanted and purified by an easy distillation process. In our case, however, the separation proved to be very difficult because of the large quantities of olefins present, particularly the conjugated or double-bond olefins such as butadiene. As soon as we added the sulphuric acid, the whole mass would set to a solid mess that we could do nothing with.

We did not get very far with our Dripolene until the use of butadiene in synthetic rubber began to cast its shadow before it but then we found if we first removed the butadiene from the Dripolene, the rest of the material fell apart very easily and we now were able to recover all of the values in our Dripolene but it was the separation of the butadiene that started us on our way.

The Second World War was on by that time and, since our rubber supplies were cut off, the importance of synthetic rubber, on which a number of companies had already been working, became overnight of transcending importance. There already was a method of making butadiene from the butenes found in the gas from oil refineries but we worked out a method of making it from ethyl alcohol and we were asked by the Government to build the first butadiene-styrene plant at Institute, West Virginia. This plant went into operation on January 29, 1943, and during the first year of operation, produced 155,000,000 pounds.

The Government subsequently built two other plants based upon our process, one operated by the Koppers Company near Pittsburgh, the other in Louisville, Kentucky, which we operated. The construction of plants to produce butadiene from petroleum products was proceeding feverishly but, nevertheless, it was butadiene from alcohol that saved the day. In 1943, the three alcohol-butadiene plants produced 260,000,000 pounds or 82.4% of the total 315,000,000 pounds of butadiene made that year. In the year 1944, 724,000,000 pounds or 64% of the total production of butadiene was made from alcohol. For the whole war period, the alcohol process produced close to 1,500,000,000 pounds or 54% of the total quantity produced for the U.S. Government.

Alcohol

Of course, alcohol was very expensive at that time, running up to \$1.00 to \$1.25 a gallon, so butadiene from alcohol, while meeting the war emergency when prices did not matter, could not compete after the war when the petroleum production plants were finished and were able to produce butadiene at much lower costs.

No plant for the production of butadiene from alcohol is in operation in the United States as of this moment but, in view of the present low price of alcohol and the demand for butadiene, this situation will probably change. It may also be of interest to

you to know that an Italian company has recently purchased the rights to our process for Italy and is presently building a plant to make butadiene from alcohol. The alcohol, incidentally, will be made under license by another of our processes from the methane in natural gas, of which Italy now has a good supply. Their economic conditions, of course, are different from ours but because of the conditions under which they operate, this will be the most economical way for them to make butadiene which, by the way, will be converted into synthetic rubber—30,000 tons per year for which the Italians have a very great need.

I might add our process for the production of ethyl alcohol from methane also produced a co-product gas that may be used in turn to produce methyl alcohol or ammonia. The Italian firm which, by the way, is called ANIC has chosen to produce ammonia from which they will finally manufacture ammonium nitrate and ammonium sulphate, 300,000 tons a year of it for which Italy has also a great need.

Hydrogenation

Finally, we come to the matter of Coal Hydrogenation. I have left this until the last because, at the moment, it seems to be the hardest thing we have ever tackled. Once again, as was true in the case of ethylene chlorhydrin, ethylene oxide and the oil of the Dutch chemists, we were not the first to hydrogenate coal.

Our objective, however, was completely different from that of the early workers in this field who strove to produce gasoline or liquid fuels from coal. We are not interested in this phase of the work at all. We think, at least so far as the United States is concerned, that the petroleum people are doing a very good job in producing gasoline, diesel fuel and fuel oil and we have no hope or thought of challenging them. This is not entirely altruistic on our part because, so far as we can see, the procuring of these products from coal would be considerably more expensive than the manner in which they are now produced from natural petroleum.

Our interest is in the chemicals that can be derived from coal. The type of hydrogenation that we employ is not so drastic as the hydrogenation the Germans or the British use. Coal is not just carbon as most people seem to believe, but is instead a huge hydrocarbon macro-molecule. A little bit of hydrogen, along with temperature and pressure, causes this molecule to fall apart but, if the treatment is right, it falls apart into rather large molecules instead of very simple ones; such as, methane, benzene and toluene. Of course, we cannot completely avoid the production of these lower materials but we are endeavoring to concentrate our production on xylene and the xylenols; naphthalene and its homologs, the phenols; the bases and their homologs, such as quinoline, indol, indanol and products such as fluoranthene, phenanthrene and a great many other compounds that have not hitherto been available in large quantities at reasonable prices.

It has been a long, hard and bitter battle. Our chemistry is sound but the mechanics are very difficult in dealing, as we are, with pressures in the range of 3,000 to 10,000 pounds

and temperatures from 400° to 700° C. To do this on an industrial scale is a large program. We found that out the hard way. We have had to revamp and modify our unit plant, that originally cost millions of dollars, very extensively but we think we are now very close to an economical solution of our problems.

It will probably be another year or two before we can finally run up the flag but I do think our hardest and darkest days are behind us on coal hydrogenation and, when I look back on the early days of ethylene glycol, Vinylite and polyethylene, it may be in retrospection this coal hydrogenation job will in the end prove to have been no more difficult than they were; the difference, of course, being in the magnitude of the operation. We, for example, think a plant to hydrogenate approximately a thousand tons of coal per day is the minimum size for economy while the optimum size may be anywhere from 3,000 to 6,000 tons per day. This will mean a huge investment—a plant to hydrogenate a thousand tons of coal per day with all of its facilities, including hydrogen production, will probably run anywhere from $50,000,000 to $100,000,000 which illustrates once again the need for men of daring and vision who are willing to embark upon voyages over uncharted seas and wager their whole futures on a successful outcome of this kind of venture. It also requires, of course, understanding, brave and brilliant management who have the ability and willingness to invest large sums of money which will return to them slowly and, in some cases, perhaps not at all.

On the other hand, when you are first in the field, the successful fruition of these explorative expeditions can be very soul-satisfying indeed and of great financial benefit to stockholders. At least, it has brought the Carbide and Carbon Chemicals Company of Union Carbide and Carbon Corporation from a mere glint in a few imaginative and daring persons' eyes to the position of one of the largest chemical companies in the world.

Patient Money

The term "patient money" has been applied to this type of forward-looking investment and sometimes it must be very patient indeed. We used to have an expression "Seven years from test tube to tank car." But that was back in the early days when the field of aliphatic chemistry was still a virgin one and quite unplowed. Almost every time one turned around, you could bring up a new compound for which a use could be developed and in those days, from the conception of the idea in the laboratory to its commercial sale in tank cars did in truth take about seven years but for harder problems like Vinylite and coal hydrogenation, the seven years are not quite enough.

It was 10 years from the conception of the idea until we were certain Vinylite was a commercial success and we have been working on coal hydrogenation since 1936, nineteen long years, but if in the end our dreams come true they will have come true because a whole group of patient, hard-working, imaginative and brilliant scientists were willing to spend years and years of their lives on a great and important but hitherto un-

solved problem and they in turn were backed up, supported and encouraged by a management who, although sober and mindful of their stockholders' trust, had also a little of the touch of genius, at least the reflection of stars in their eyes, and a clear recollection of what similar situations had led to in the past.

When this happens, we are going to be able to offer to the American public a whole series of new aromatic compounds, new in the sense that they are not presently available in large quantities at reasonable prices and we hope that we may be able to do in the field of aromatic chemistry what we modestly claim to have done, or at least largely helped to do, in the field of aliphatic chemistry.

Nylon Dyeing Allows Hot Washing

➤ SUCCESS is reported in dyeing nylon so that delicately tinted lingerie can be washed in near boiling water instead of in baby-bath temperature water.

A new patent-applied-for process for dyeing filament nylon yarn that makes this possible has been developed in the Chemstrand Laboratories at Decatur, Ala.

Walter H. Hindle, associate director in charge of textile research, explained that whereas 120 degree Fahrenheit wash water has been considered tops for safe washing of nearly all such dyed filament nylon products, nylon dyed by the new Chemnyle process can be safely washed at temperatures of 160 degrees, and in some cases up to 212 degrees, and the color stays fast.

The new process provides a previously unmatched combination of dyeing uniformity and colorfastness worthy of the long lasting qualities of filament nylon yarn. Nylon can now be successfully dyed in fast color for a variety of end products including taffeta, tricot, sweaters and half-hose.

New Hydrocarbon Fuel From Western Mineral

➤ A NEW solid fuel, neither coal nor asphalt, although it resembles both, is about to be tried out in Salt Lake City. Latest mining and transportation methods are put to use in a new processing plant, to be completed in 1957, which will make high purity coke out of an unusual geological formation found near the site.

The formation, known to geologists as Uintaite, is of hydrocarbon origin. Black like coal, it contains more resin and less sulfur than asphalt. Petroleum-like by-products, similar to those from oil shale, are expected to be recovered in the coking process.

Barber Oil Corporation and Standard Oil Co. of California have joined in the effort to adapt the hydrocarbon mineral to fuel use. They have renamed it "Gilsonite," after an early explorer of the formation where it is found, and are building the processing plant near Grand Junction, Colo. A six-inch pipeline will be used to pump a suspension of the mineral over the mountain from the mines at Bonanza, Utah.

Highlights From
Atlantic City Meeting

American Chemical Society Reports

➤ DISTILLATIONS from the Atlantic City meeting of the American Chemical Society.

America can produce enough food for a billion population but we are in danger of overpopulation from the standpoint of space alone, Dr. Firman E. Bear, editor of Soil Science, said. Some of the most productive land we have is being lost to cities, superhighways, factories and reservoirs. Each year population added is equivalent to a 60,000 city in each of the 48 states.

A new nitrogen fertilizer "spoon-feeds" blue grass turf all summer long even though it is applied only once in the spring, Dr. Frank A. Gilbert of Batelle Memorial Institute, Columbus, Ohio, reported.

Citric acid, which gives the tang to soft drinks, can now be used in making polyester resins, Dr. Charles J. Knuth of Chas. Pfizer & Co., Brooklyn, N.Y. reported.

Asphalt can be converted into gasoline and various oils by combining it with by-product hydrogen of oil refineries, R. L. Heinrich of Humble Oil and Refining Company, Baytown, Tex., announced. About 105 barrels of products can be obtained from only 100 barrels of asphalt.

A new synthetic rubber can withstand the heat of supersonic jets, frigid temperatures of the upper air, as well as the attack of fuels, lubricants and hydraulic fluids, Dr. G. C. Schweiker of the Hooker Electrochemical Company, Niagara Falls, N.Y., reported. It is a polyester made from adipyl chloride and a diol containing fluorine.

Radiation Into Chemical Energy

➤STEPS TOWARD the conversion of atomic radiation into chemical energy, one of the most important objectives in atomic energy development, were detailed by Drs. R. H. Schuler and N. F. Barr, reporting work done at the Brookhaven National Laboratory.

Ionizing radiations were used to oxidize an iron salt, ferrous sulfate, in the research aimed directly at understanding the decomposition of water by radiation. This gives information on the direct effects of radiation on chemical change.

Most atomic energy is used by degrading the radiation energy into heat and then using the heat to produce chemical or other effects. Radiant energy such as in the sunshine is converted directly into chemical energy in the green leaf by the process called photosynthesis. An equivalent in atomic energy would be desirable.

In the Brookhaven experiments slow neutrons from the atomic reactor there were used to bombard both boron and lithium, giving alpha particles in both cases and lithium particles from the boron and tritium from the lithium. The latter is the method of making tritium that may figure in the H-bomb.

The resulting radiations were used in the chemical experiments. The

conversion is not very efficient from the standpoint of energy, but the process studied has the value that it is reproducible accurately.

Dr. Schuler is now heading the new radiation division of Mellon Institute, Pittsburgh.

Stretch Meat Supplies

➤ SYNTHETIC chemicals can stretch the world's meat and poultry supplies of proteins. This promise appears from research reported by Dr. Hans R. Rosenberg of the Du Pont Company's Stine Laboratory, Newark, N.J.

The stretching will come through cheaper protein feeds for livestock and poultry. This will be accomplished through supplementing the cheaper feeds with synthetic amino acids used by animal and human bodies to build protein.

One of them, methionine, is now available from the chemical industry at a cost permitting its use economically in commercial feeds, Dr. Rosenberg said. Another, lysine, is now in limited pilot plant production but presumably will be available before long in commercial quantities.

Methionine and lysine are the two amino acids most likely to be deficient in mixed feeds for domestic animals.

Human diets throughout the world are also affected by the fact that cereal grains are generally low in lysine. This amino acid is now being put into a few specialty breads and in some cases the acid has been used as a diet supplement to improve appetite and growth of babies.

Stretching the world's protein supply may also be accomplished by changing ideas on nutrition. The amount of protein needed in the daily diet of animals and man may be different than believed, recent studies cited by Dr. Rosenberg suggest.

The methionine requirement of chickens and turkeys, it has been found, is governed by the calories in the feed. The same principle applies to lysine in hog rations.

Super-pure Silicon

➤ AN ALMOST PURE silicon and the technique for making it promise to help man conquer outer space.

A description of the silicon, so pure that it has only one part of contaminants in 6,000,000,000 parts of the element, was given by Dr. Bernard Rubin of the Air Force Cambridge Research Center, Bedford, Mass. This degree of purity is equivalent to having only one kernel of corn in 10 railroad carloads of wheat.

The near-pure silicon now permits the manufacture of transistors that could withstand heats up to almost 600 degrees Fahrenheit. Present transistors made from the element germanium operate at temperatures up to about 200 degrees.

The use of the purified silicon will result in superior electronic "brains" and "nerves" to control improved rockets and help fly advanced jet planes.

The significance of the new purification technique, he said, "lies in the fact that it may be possible to obtain silicon of a quality suitable for semiconductors. Then rectifiers, switching devices, amplifiers, photodiodes, and negative resistance diodes may be produced for high temperature operation. In aircraft, less power will be required for electronic components, and heat emanation will be minimized."

Capt. Guy H. Moates and Joseph R. Weiner, chemists at the research

center, worked with Dr. Rubin in producing the purified silicon.

Nerve Gas Alarm

➤ In case of a nerve gas attack, the alarm can now be given, audibly and visibly, by automatic devices which detect the deadly colorless, odorless gas in quantities "too small to affect human or animal life."

The devices include a portable one for Army field use that can be dropped by parachute.

Besides their value for protecting troops and civilians in case of war, the devices can be adapted for use in nerve gas arsenals and plants, laboratories, to detect the new insecticides which are related to nerve gas, and to detect other gases such as "silo gas" that sometimes kills farmers.

For combat is the portable B21 developed jointly by the U.S. Army Chemical Corps and Radio Corporation of America. It is waterproof, about the size of a portable typewriter, weighs about 25 pounds, is highly sensitive, yet tough enough to withstand parachute drops, reported John C. Young, physical chemist at the Army Chemical Center, Edgewood, Md.

This device filters a sample of air to remove dust, then passes the air through a paper tape which has been wetted with a solution of ortho dianisidine and sodium pyrophosphate peroxide. This solution turns red if nerve gas is present. Photocells react to the red color on the paper tape by triggering an audible and visible alarm. The B21 will operate continuously for 12 hours on 24-volt direct current electricity. After 12 hours it can be serviced and put into operation again in a matter of minutes.

The B21 is relatively cheap in cost and has been designed for mass production if required. By using different chemical reagents, it can be adapted to detect other gases and is believed to have broad applications to industrial air pollution.

A different chemical-electronic system, using "black light," works the gas alarm device reported by Harold R. Smith of the Chemical Warfare Laboratories and a team of chemists of Leeds and Northrup Company, Philadelphia. This instrument, which is not portable, uses chemicals which fluoresce under "black light" to detect as little as one part of nerve gas in 10,000,000 parts of air. It is being used at the Army's Rocky Mountain Arsenal among other places.

Neither visible light nor fluorescent light is needed for the nerve gas alarm reported by Jerome Goldenson of the Chemical Warfare Laboratories. This device operates on a chemiluminescence principle.

"The most promising potential use for the new chemiluminescence method (which produces light by reaction of the nerve gas with the chemical, luminol) is for continuous automatic sampling of the atmosphere," Mr. Goldenson declared.

Smog Ingredients Found

➤ New and more sensitive methods of identifying the compounds in "smog" have been developed by scientists in the University of California School of Public Health.

The tests may make a contribution to a better understanding of "smog" causes, said Jerome F. Thomas, Bernard D. Tebbins, Mitsugi Mukai and Eldon N. Sanborn, at the meeting of the American Chemical Society.

The tests indicate that the same compounds are found in smog in the San Francisco and Los Angeles areas, with much higher concentrations in Los Angeles being the only difference.

The scientists said the nature of the pollutants also suggests strongly that the compounds are produced only when fuels are burned incompletely.

The test procedure is complex. First, the air is filtered. A million cubic feet of air yielded two grams, a fraction of an ounce, containing more than 45 compounds.

The crude material is then separated chemically into four general groups. Two advanced scientific techniques, chromatography and electrophoresis, are used to break the compounds down further.

Final identification is made by means of a spectrophotometer, which measures precisely the wave length of the color of each compound. The colors of smog compounds are compared with those of known compounds.

➤ "Our *mining stock hit pay dirt!*"

H-Bomb Reactors Could
Manufacture Heavy Elements

All Elements Made Inside Stars

➤ ALL KNOWN ELEMENTS of which matter is composed including those man-made in the laboratory, can be built up in the hot interior of stars.

Hydrogen bomb-type reactions occuring in less than a second can account for abundances of heavy elements, Dr. A. G. W. Cameron, Atomic Energy of Canada, Ltd., has concluded.

Previous theories of element-building have explained the known amounts of the light elements, but have run into difficulty on the heavy elements. Many heavy elements can be formed only on such a fast-time scale, Dr. Cameron reported to the American Astronomical Society. Of particular interest, is formation of californium 254, an element first made by man in 1950. Californium 254 is heavier than uranium and, like uranium, spontaneously breaks up, or decays, half of any given amount disappearing in 55 days.

This same period of 55 days is observed in the light curves of supernovas, stars that come to a spectacular end by exploding.

Dr. William A. Fowler of California Institute of Technology, suggests that californium 254 may be built in supernovas, as shown by production of this element in the H-bomb test at Bikini in November 1952.

Dr. Fowler also concludes that two kinds of uranium, the fissionable kind of atomic bomb fame and the much more plentiful isotope, were formed in equal abundance in the Milky Way galaxy before the earth was formed, instead of the present ratio of only one atom of uranium 235 for every 140 atoms of uranium 238.

Using the known decay rates of the two uraniums, Dr. Fowler calculated that element formation started at least seven and a half billion years ago. This figure is about two and one-half billion years above the currently estimated value for the age of the universe.

The studies reported by Drs. Cameron and Fowler are part of a broad-scale attack on the problems of the origin of the elements and stellar reactions being made cooperatively by several scientists, including Prof. Fred Hoyle of St John's College, Cambridge, England, now working in Pasadena; Drs. G. R. Burbidge and Mrs. E. M. Burbidge of Mt. Wilson and Palomar Observatories, Pasadena, Calif.; Dr. R. F. Christy of California Institute of Technology, Pasadena; Dr. Jesse L. Greenstein, Mt. Wilson and Palomar Observatories; Dr. Martin Schwarzschild, Princeton University; Dr. Harold C. Urey of the University of Chicago and Dr. Hans E. Suess of the U. S. Geological Survey.

Sunshine is a contributor to smog; when weak winds permit the accumulation of pollutants beneath the inversion layer, then sunlight may cause chemical reactions.

Chemists Apply Principles To Making Useful articles

Patents in Chemical Fields

To obtain copies of these new patents, order them by number from the Commissioner of Patents, Washington 25, D. C. Enclose 25 cents in coin, money order or Patent Office Coupons (but not stamps) for each patent ordered.

Radioactive Battery

➤ THE U.S. GOVERNMENT was recipient of the rights to a radioactive battery. The atomic age battery, its inventors state, has a life that depends only upon the half-life of the radioactive source; it is compact and mechanically free, having few moving parts. It can be made cheaply.

The gas-filled battery, called a radioactive charging device, is carried in a Lucite frame. Its potential is set up between metals having different work functions. The inventors, Richard R. Annis of Colebrook, N.H., and Howard Haselkorn of Asbury Park, N.J., found that best results are obtained when gold, platinum or copper is used with aluminum. The battery is filled with a beta particle emitting radioactive source, such as strontium 90 or thallium 204. The inventors were granted patent No. 2,758,225.

Beer Foam Preserver

➤ DEXTRANS, used as a substitute for blood plasma, are now being put to work to keep a "head" on beer.

Foaming of beer results from the presence of certain proteins, gums, hop resins, minute traces of esters, organic acids and higher alcohols in the beverage. These lower the surface tension of the beer and form an interlocking network that traps the gas bubbles as they float to the surface. This action, however, lasts for only a few seconds.

Now, Harry A. Toulmin, Jr., of Dayton, Ohio, has come up with the dextran additive that will keep the foam-head for a much longer period of time. The dextran can be put into the beer at any stage of its brewing. It will not, he states, change the taste, color or flavor of the brew and it is safe for human consumption. If anything, Mr. Toulmin says, the addition of the dextran improves the beer by giving it greater smoothness. He was granted patent No. 2,758,926 and assigned the patent rights to The Commonwealth Engineering Company of Dayton, Ohio.

TV Set Hung on Wall

➤ A 10-INCH thick television set that that can be hung on the wall like a painting has been invented by Pierre Marie Gabriel Toulon of New York City.

The thin set employs the principle of distributing video intelligence over the entire surface of a phosphorescent viewing screen without the need for a cathode ray tube. It operates with an ionizing gas and control electrodes.

A typical size for the wall TV, Mr. Toulon says, is a picture face having a cross-wise dimension of 42 inches and a height of about 34 inches. He adds, however, that the dimensions could be blown up to permit a TV

screen for very large audiences in both indoor and outdoor theaters.

Designed for mass production, the mural TV screen can be placed in a frame of wood or plastic and hung on the wall. Control knobs can be mounted on the frame, or located anywhere in the room, as desired. Mr. Toulon also states that the TV set is readily adaptable to color television, as well as three-dimensional television.

The mural TV screen was awarded patent No. 2,760,119. Mr. Toulon assigned the patent rights to the Products and Licensing Corporation of Greenwich, Conn., and Nelson Moore and William D. Hall.

Chemical Toy Rocket

➤ CURTISS-WRIGHT Corporation, makers of airplanes, received the patent rights to a toy rocket. The miniature rocket-propulsion device uses two chemicals, stored separately, which when mixed shoot the toy high into the sky. The toy is launched by pulling on a string. The invention of Robert B. Lewis of Glen Rock, N.J., the rocket was granted patent No. 2,759,297.

Food From Beermaking Waste

➤ BREWERS' grains are the leftovers of the malts and other materials used in brewing beer. When dried, these grains contain almost all the material used to make beer, with the exception of starch. Now, a derivative of the dried grains can be made into food for humans, as well as dogs and chicks.

The product made from the dried brewers' grains is a low fiber, high protein content food supplement having at least 45% protein, eight to 10% fat, with an approximate biological value of from 82% to 93%. The food is not malt flour, its inventors point out, but a high-protein foodstuff derived mainly from barley and useful in the nutrition of animals that cannot tolerate a feed high in fiber content, and in human nutrition. It was invented by Joseph A. Siefker of Webster Groves, and Jerome F. Brasch of Hanley Hills, Mo. Awarded patent No. 2,754,211, the inventors assigned the patent rights to Anheuser-Busch, Inc., of St. Louis, Mo.

Fire Extinguishing Light

➤ CHARLES L. ZABRISKIE of New York City has invented a combined lighting fixture and fire extinguisher. The lighting fixture contains a fire-fighting substance which in no way interferes with the light. If it gets too hot in the room, however, down comes the fire-fighting chemical. He was granted patent No. 2,759,546 and assigned the patent rights to Essex Products, Inc., of New York.

Soil Erosion Stabilizer

➤ SOIL can be kept from blowing by treating it with a chemical compound, Drs. David T. Mowry and Ross M. Hedrick of the Monsanto Chemical Company, St. Louis, Mo., have found.

Soil structure is improved when a water soluble polymer of an acrylic or methacrylic acid is dispersed through the surface layers of the soil. The two scientists, both from Dayton, Ohio, say that the particular method of application is an all important factor in the chemical's effectiveness. They suggest that it be in a dry powder or a water-pervious film.

Once the polymer is applied, they report, the effect, according to present

information, is permanent for at least one year and possibly longer. It is to be used to keep soil from eroding due to the action of wind and water, although rainfall helps to disperse the chemical throughout the soil. It is also effective until a cover crop has had time to come up and hold the soil.

The chemists were awarded patent No. 2,754,623 for their invention and assigned the patent rights to the Monsanto Chemical Company.

Sound Deadening Material

➤ STEEL panels and other wall materials can now be treated with a coating that deadens sound and eliminates the familiar ring that resounds in many offices and factories.

The coating, invented by Fred E. Kendall of Chagrin Falls, and Paul Golar of South Euclid, Ohio, can be applied to metal partitions as a thin coating or layer. In addition to its soundproofing qualities, the composition is fireproof.

The composition consists of 24% vermiculite by weight; 50% water glass; six percent sodium hydroxide; and 20% added water. When heated, the inventors say, this coating will not release combustible fumes, vapors or toxic gases and will not char or disintegrate. They were granted patent No. 2,756,159 and assigned the patent rights to The E. F. Hauserman Company of Cleveland, Ohio.

Rustproofing Compositions

➤ A RUSTPROOFING agent that adheres tenaciously to metal, particularly at high humidities, has been invented by Malvern J. Hiler of Dayton, Ohio.

The rustproofers are made from esters of dextran combined with fatty acids from eight to 18 carbon atoms. These compositions, the inventor says, are particularly adaptable for use in lubricating oils ranging from light machine and household oils to heavy lubricants and fuel oils for large internal combustion engines, including diesels.

In tests with the compositions, exposure of a treated surface to high humidity and direct contact with salt water did not result in the development of rust spots. Mr. Hiler received patent No. 2,756,156 and assigned the patent rights to The Commonwealth Engineering Company of Dayton, Ohio.

Flameproof Fabric

➤ A METHOD for manufacturing an evenly dyed, lightweight, flexible, flameproof fabric which retains its flameproofing after laundering and cleaning was granted patent No. 2,755,534. It is made of a cellulose fiber-reinforced asbestos fabric. The process was invented by Irvin Barnett of Somerville, N.J., who assigned the patent rights to the Johns-Manville Corporation of New York.

Cigarette Paper

➤ DR. WALTER G. FRANKENBURG of Millersville, Pa., has invented a cigarette paper which he claims yields a smoke substantially free of obnoxious components. According to Dr. Frankenburg, the introduction of a finely divided, mineral-type siliceous catalyst such as acid-treated clays, in cigarette paper, prevents the formation of irritants. The catalyst will not burn and the smoker does not get a foreign taste or odor. He was awarded patent No. 2,755,207 and assigned the patent rights to General Cigar Co., Inc., of New York.

Milkman To Bring Safe Water

➤ In case floods or other disasters knock out a town's water supply system, the milkman will come to the rescue, bringing safe drinking water packaged in milk containers.

The plan originated, apparently, when Hurricane Diane hit Stroudsburg, Pa., in August, 1955, bringing torrential floods that put the water plant out of commission. Local civil defense authorities called the Lehigh Valley Cooperative Farmers Dairy in Allentown, Pa., asking for milk cartons. The Lehigh group responded by sending the cartons filled with pure drinking water sealed in the cartons to avoid contamination.

The Lehigh group did this by simply switching their dairy from packing milk to packing water. The same machinery was used.

Following this successful experiment, FCDA consulted the U.S. Public Health Service, American Red Cross, milk and dairy and container industries and the plan resulted.

It proposes that in any emergency dairies in areas affected would package water, in containers usually used for milk, for shipment by air, rail, truck or water to the disaster regions.

It would be the responsibility of the civil defense director in any community where the water supply was knocked out to determine the need for drinking water and the amount required. He would appeal to the nearest dairies still in operation and make arrangements for packaging and shipping the drinking water to his community.

Several companies are using hand stamps, special caps or inserting the regular caps upside down to identify the specially-packaged water. Two companies are even producing special cartons.

Book Condensations

Robert Hooke — Margaret Éspinasse — *University of California Press.* 192 p., illus., $3.75. A biography of a distinguished scientist who served the Royal Society from 1662 until his death in 1703. The book was inspired by a study of Hooke's diary.

Chemical Engineering Kinetics — *McGraw-Hill,* 402 p., $8.00. Presenting sound design methods for several types of reaction equipment. Suitable for fourth-year undergraduates and graduate students.

Laboratory Experiments in General Chemistry — G. Brooks King and William E. Caldwell — *American Book Co.,* 324 p., illus., paper, $3.25. The experiments are arranged to accompany the authors' text, "The Fundamentals of College Chemistry."

Measurements of Mind and Matter — G. W. Scott Blair — *Philosophical Library,* 115 p., illus., $4.50. The science of measurement cuts across all the fields of science from the measurement of movement of the movement of electrons to the measurement of human intelligence. This book is written for the layman.

Experimental Physical Chemistry — Farrington Daniels and others — *McGraw-Hill,* 5th ed., 482 p., illus., $6.50. Intended to train in careful experimentation and to encourage ability in research.

The Condensed Chemical Dictionary — A Reference volume for All Requiring Quick Access to Essential Data Regarding Chemicals and Other Substances Used in Manufacturing and Research, and to Terms in General Use in Chemistry and the Process Industries — Francis M. Turner, completely revised and enlarged by Authur and Elizabeth Rose — *Reinhold,* 1200 p., $12.50. Containing over 30,000 entries.

Process Chemistry — F. R. Bruce, J. M. Fletcher, H. H. Hyman and J. J. Katz, Eds. — *McGraw-Hill,* Progress in Nuclear Energy, Series III, 407 p., illus., $12.00. Reference material for those actively engaged in the chemical aspects of atomic energy.

The Chemistry and Technology of Waxes — Albin H. Warth — *Reinhold,* 2d ed., 940 p., illus., $18.00. A ready reference work for chemists and industrialists.

On the Cell Model for Solutions — Stuart A. Rice — *New York Academy of Sciences,* Annals, Volume 65, Art 2, 24 p., paper, $1.25.

Progress Report on Atomic Energy Research: Hearings before the Subcommittee on Research and Development of the Joint Committee on Atomic Energy, Congress of the United States — Melvin Price, Chairman — *Govt. Printing Office,* 375 p., illus., paper, $1.00. The most comprehensive current report on the subject available. The experts hav poured into this record facts and illustrations galore.

Polymer Solutions — H. Tompa — *Academic,* 325 p., illus., $8.50. Dealing essentially with the thermodynamics and the viscosity of polymer solutions.

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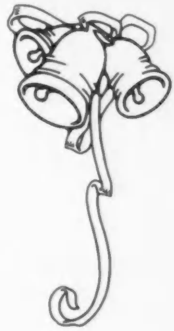

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